Technology Review

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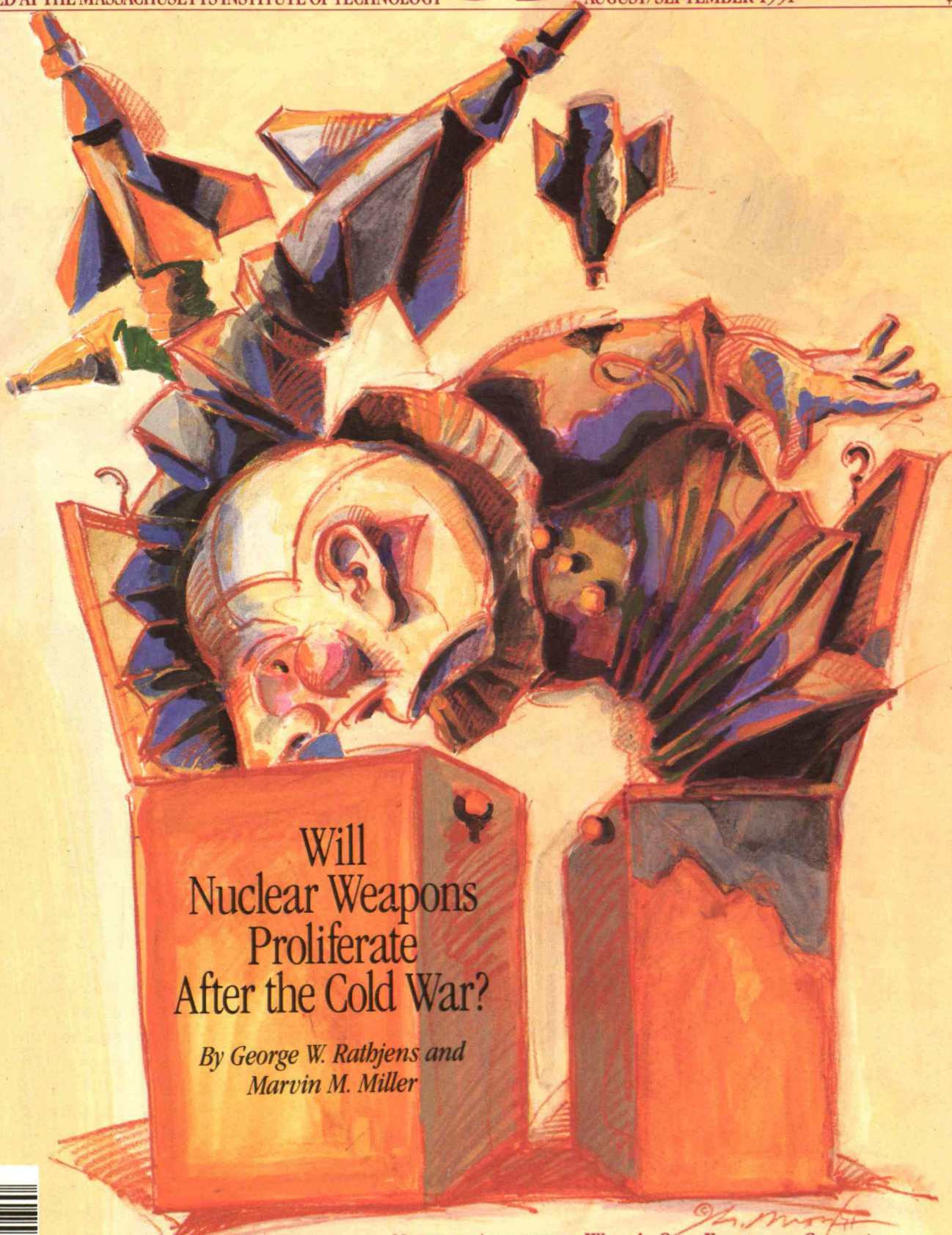

Will Nuclear Weapons Proliferate After the Cold War?

By George W. Rathjens and Marvin M. Miller

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AUGUST/SEPTEMBER 1991

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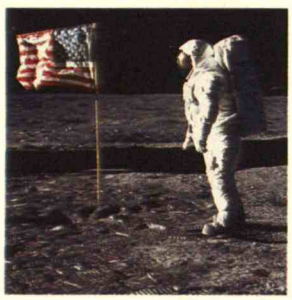

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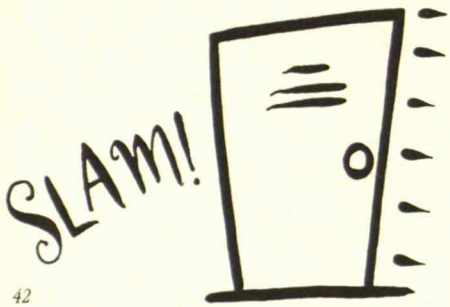

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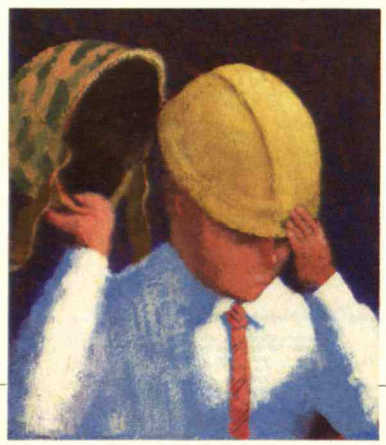

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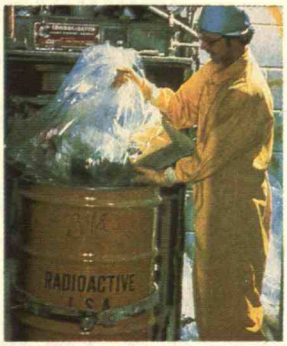

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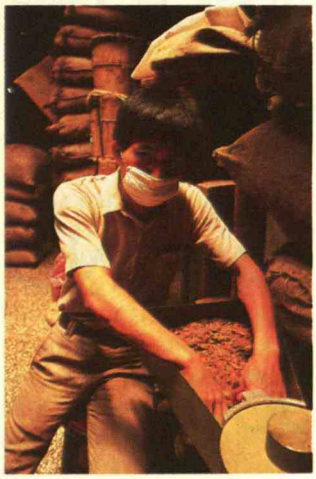

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FirstLine

An Economic Transition

CLAUDETTE Munson crafts the printed circuit boards that form the brains of some of the most sophisticated weapons in the U.S. arsenal, including the Navy's Trident missile. A highly skilled machine operator for nearly 20 years at Unisys Corp., the nation's fourth-largest computer manufacturer, Munson was laid off for nine months last year because of declining defense sales.

She is far from alone in her fate. Over the past several years Munson has watched some 3,000 of her fellow defense employees lose their jobs at the company's St. Paul plant because of cutbacks in the nation's military budget. The Pentagon's Office of Economic Adjustment anticipates that a modest 10 percent defense cut over the next five years will throw 650,000 people out of work—with a ripple effect displacing at least that many in related industries. The end of the Cold War clearly stands to bring economic hardship to millions.

Advocates of a smaller military budget have long argued that the nation must plan for the day when defense workers will need other employment. As the desperate pleas of the numerous communities now facing base closings attest, waiting until the axe falls does not work.The first step in making any such transition is to find civilian goods that need producing. This is not an easy task given the worldwide glut of consumer items, as John E. Ullmann points out in this issue (*see "Building a Peacetime Economy," page 56*). A second crucial ingredient in shifting to peacetime work is drawing on the expertise of both managers and workers.

Unisys is a case in point. As layoffs mounted in the late 1980s, Munson and her union, Local 2047 of the International Brotherhood of Electrical Workers, decided to survey Unisys employees for civilian goods the company could pursue. Engineers, production workers, and machine operators at the St. Paul plant suggested over 120 products from VCRs to fiber optics. How to choose which ideas had practical merit?

The employees formed an Alternative Use Committee, which hired a market consulting firm to narrow the list of products to those that could both fill a commercial niche and apply the skills the workers, largely women, had honed during decades of fabricating precision military hardware. At the same time, the committee focused on new markets for the advanced computer systems the company—the product of a 1986 merger of Burroughs and Sperry—had long specialized in making.

The end of the Cold War stands to bring economic hardship to millions.

The consultant's report, issued in June 1990, targets the central computers needed to monitor and analyze road conditions for intelligent vehicle highway systems (IVHS), as well as computers to run high-speed rail. Remote-sensing systems and technologies for aiding disabled people, including robotic hands and environmental monitors, also made the list, among others. Many of these technologies rely on rugged computer processing developed for the military and made possible by Munson's specialized circuit boards.

Although community support for the project has been strong (Mayor Jim Scheibel and former governor Rudy Perpich have actively campaigned for it), Unisys's response has been tepid. Managers have participated only reluctantly in meetings of the Alternative Use Committee, and they have evinced little interest in its proposals. However, the company did recently announce plans to produce a satellite tracking system similar to that needed to run an IVHS. While Munson believes the move proves the validity of the workers' proposals, the announcement disappointed: the system will be made in Salt Lake City. Meanwhile layoffs in Minnesota continue.

Both the Pentagon and defense firms have long opposed efforts to make military-civilian planning mandatory. Managers seem to fear, as Unisys division director Bill Marberg attests, losing their perogatives to determine what a company produces. Munson insists, however, that her committee is not interested in shoving production decisions down anyone's throat—if, indeed, employees had such power. She simply wants managers to tap the knowledge and experience Unisys employees have accumulated.

In the absence of strong federal leadership, efforts by states and local authorities to plan for defense-related job losses are gaining momentum. Washington state is surveying companies to determine their defense dependency and find out what alternatives they are considering. Maine may assist firms wanting to retool for the commercial sector. And seed money can be crucial: the Minnesota Office of Economic Dislocation has provided $10,000 to the Unisys Alternative Use Committee to complete the third phase of its market analysis.

Such efforts will best succeed with a clear mandate for advance planning at individual firms. For conversion to work, managers will have to both give up their opposition to planning and listen to their workforce. Such listening, after all, would simply build on the move toward greater shop-floor democracy now touted as the key to productivity. If the nation refuses to draw on the accumulated knowhow of its defense employees, much of the potential technological spinoffs from decades of military buildup will be lost.

Clearly, those who have devoted their working lives to ensuring the success of that policy deserve help in making a transition. As Claudette Munson says, "I just want the chance to try."

SANDRA HACKMAN

TechnologyReview

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Letters

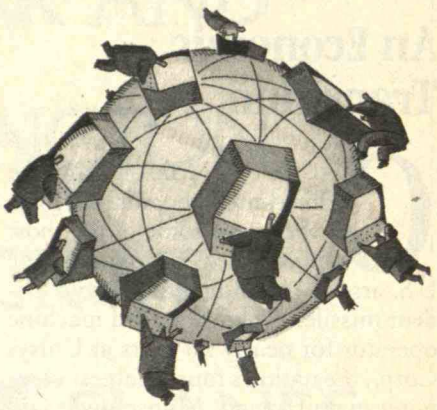
INFORMATION INTERSTATES

I congratulate Michael Dertouzos (*"Building the Information Marketplace," TR January 1991*) and Jonathan Schlefer (*"Building the Information Highway," TR First Line February/March 1991*) on a clear and interesting vision of electronic infrastructure issues.

I do not agree, however, with Mr. Schlefer's view of the relationship between the public and private sectors. Most economic activity in our society is organized by the private sector, and major federal government initiatives to develop information infrastructures must work within that situation. There is a growing consensus that the government should make information it has garnered available to the public, but the government should not ordinarily invest in information gathering or distribution that is unnecessary for its functioning and that has historically been left to the private sector. An example is large public dialup bulletin boards and the communications support, such as packet networks, needed to place them within the reach of everyone.

I do believe the government should actively promote development of formats that enable people to exchange information freely. I also think the government should support pilot projects that would demonstrate different ways of organizing electronic publishing and its markets. We also need new regulatory and legal concepts to fit new technologies—the government could help there, too, focusing on pricing, usage metering, and billing and collection techniques, as well as associated intellectual-property, antitrust, and economic regulation issues.

Beyond that, however, I am skeptical. Most of the great successes of the microcomputer revolution have been entrepreneurial and market-driven, not artifacts of a national plan. In fact, a national plan more likely would enshrine tomorrow's equivalent of mainframes, remote time-sharing, and hundred-thousand-dollar software packages at the expense of desktop computing, local area networks, and competing $500 user-friendly word processing and spreadsheet products. Furthermore, I see no reason why the First Amendment should prohibit the telephone company, which Mr. Schlefer calls a "powerful local monopoly," from competing with the *Boston Globe,* which looks to me like another powerful local monopoly. What we need are regulations that encourage vigorous innovation and competition—not a national straitjacket.



Political reality makes it extremely unlikely that a system such as the one Mr. Dertouzos proposes will be funded in one fell swoop. The cost is too high and the competition with the private sector too broad and too fundamental. The vision of an information highway can become a reality only if government people work with the private sector on some carefully crafted experiments.

HENRY H. PERRITT
Villanova, Pa.

In arguing that a national information network should be developed by the government rather than entrepreneurs, Jonathan Schlefer would have done well to find a more persuasive model than the interstate highway program. The history of that program shows only how easy it is for the government to dole out money and how hard it is to oversee the outcome.

The legislation for interstates reflected the theory that what's good for General Motors is good for the country, and it was in fact good for General Mo-

tors and the other companies in the automobile, tire, and petroleum industries that lobbied for it. With the end of World War II, these companies shared a valid concern that the demand for their products would stop growing. To ensure that nothing so crass as price would dissuade people from consuming more, the interstates were made toll-free. The entire system was thereby insulated from the discipline of the marketplace.

Unfortunately, the result has been congested urban highways and overinvestment in rural highways. We might be better off today if entrepreneurs *had* been in charge. That way the requirement to turn a profit would have tempered the tendency to overbuild in rural areas, and market pricing and investment standards would have better matched capacity to demand in urban areas.

Interstate highways have facilitated urban sprawl, which has translated into low off-the-job productivity for American workers. A well-known symptom is resource consumption per capita, which is greater in the United States than anywhere else—even countries where the standard of living is as high or higher. American workers must be paid more to maintain their lifestyle than their counterparts in societies where off-the-job productivity is better.

Without the interstate program, industries other than motor vehicles, rubber, and petroleum would have flourished. As Schlefer himself suggests, our environment might be less threatened. We might be less dependent on imported oil. Our central cities might still be healthy. Our society might be less divided between the poor, who cannot afford cars, and the rest of us. And our children might enjoy better chances of success in a competitive world.

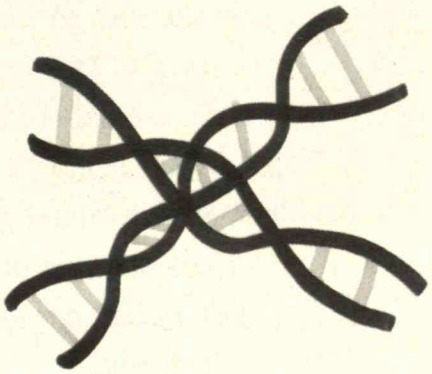
The interstate highway program is like bread production in the Soviet Union—bread there has been priced so far below cost that farmers find it cheaper to feed bread to their pigs than grain. Now that Soviet central planners have realized the error of their ways, they face consumer riots against price increases. American motorists, who have been driving toll-free for three decades, would be equally ready to riot if threatened with charges sufficient to cover the full costs of highway use.

ROBERT R. PIPER
Berkeley, Calif.

GENETIC DETERMINISM

As a member of the lay public inclined toward genetic determinism, I found Robert Weinberg's dread as expressed in "The Dark Side of the Genome" (*TR April 1991*) a little extreme. He writes defensively, "Environmental variations can cause genetically similar individuals to develop in dramatically different ways." Of course this is true: they are only similar. But what about genetically identical individuals?

An ongoing study at the University of



Minnesota suggests an incredible correlation in the behavior of identical twins raised apart compared with those raised together. If the data continue to hold up, one could conclude that as much as 70 percent of all human behavior is directly controlled by genetic make-up—right down to the choice of toothpaste.

An interesting point I believe Mr. Weinberg missed is that if genetic determinism is as real as the twins study suggests, what difference does it make whether the public believes in it or not? Mr. Weinberg is afraid that people would put their faith in genes and lose their "spunk, ambition, and passion," but actually there would still be plenty of people who exhibit those admirable qualities: since they'd have the genes for them, they'd have no choice. The important question is, If genetic determinism is real, what role will it play in determining which genes survive? Will it accelerate natural selection or destroy it? It might do neither.

One especially interesting aspect of genetic determinism is the theory of the "selfish" gene. This theory, which says people are disposed to prefer their own kind, indicates that even with complete genetic diagnostic information and power to manipulate genes, parents would still choose to have offspring who are pretty much like themselves. Thus the overall genetic picture would remain basically the same.

I believe that instead of expressing dread at the spectre of genetic diagnosis and selection, we could celebrate it. After all, we'll have meaningful power of free choice for the first time in human history.

KEVIN MAGINNIS
Chicago, Ill.

Robert Weinberg's article raises deep questions. The call to "craft an ethic that cherishes our human ability to transcend biology" is well taken, but another aspect of the problem, which Weinberg ignores, is the reductionistic way of thinking that's implicit in trepidation over "genetic determinism" in the first place.

Genes, in and of themselves, do not "cause" anything. Genes interact with the environment to produce their effects. No section of any chromosome, in and of itself, causes Huntington's disease (as the diagram on page 51 of the article may lead one to suppose). It may be more convenient to discriminate against individuals with certain genes than it would be to modify the environment within which they work and live. Hence the issues at stake are as much political and economic as they are "ethical."

MICHAEL BRADIE
Bowling Green, Ohio

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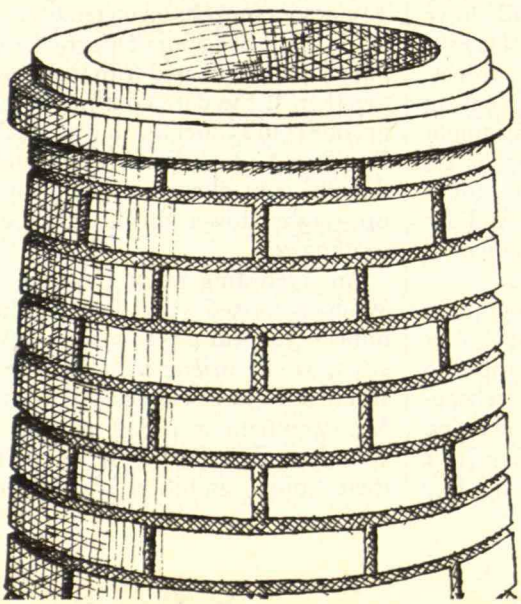

MIT Reporter

Low-Level Waste, High-Level Problem

MIT's radiation protection chief is not looking forward to New Year's Day 1993. According to current plans, on that day a federal law will force universities, hospitals, and businesses in perhaps 39 states to start storing their own low-level radioactive wastes instead of shipping them to a licensed disposal site.

"Every user in the state will become a waste disposal site," says Francis X. Massé, director of the radiation protection program at MIT. Virtually all of MIT's low-level waste—experimental waste, radioactive lab equipment, and unused chemicals—now goes to a special dump in South Carolina. But when the law goes into effect, the Institute will have to hang onto its wastes until a new disposal site is built. The forthcoming change worries Massé, who is also the president of the Health Physics Society, a professional organization concerned with radiation's effects.

Experts point out that on-site storage heightens the risk of accident and may unnecessarily expose workers to radioactivity. Massé says he fears the law could also lead to illegal dumping of low-level wastes by some generators. And while environmentalists agree with the law's intent—making all states responsible for their low-level waste—they say that the details for realizing that have not been sufficiently thought through.

What an Act Hath Wrought

Temporary on-site storage is just one of a sweeping series of changes begun in 1979 by the governors of South Carolina, Nevada, and Washington, the only states operating LLRW disposal sites today. Responding to concerns about distributing responsibility for the waste among all the states, Congress encouraged the building of new disposal sites by passing the Low-Level Radioactive Waste Policy Act in 1980.

A worker prepares low-level radioactive waste for temporary storage. Where much of such waste will find its final resting place come 1992 is anybody's guess.

A series of get-tough amendments followed in 1985, to goad foot-dragging states into action. These required each state to decide by 1988 whether it planned to enter into a regional waste pact or go it alone. By 1993, each state is supposed to have its own disposal site or long-term access to one elsewhere. Any state without access to a waste site by 1996 will have to take title and legal responsibility for every bit of LLRW generated within its borders.

Now it looks as if MIT and other waste producers across the country could be left holding the bag in 1993. Because they don't want to continue accepting much of the nation's LLRW, the South Carolina and Nevada sites plan to close that year—even though both are less than a quarter full.

Meanwhile, the Washington site will remain open only to seven Western states. Four other Western states may be able to send their LLRW wastes to a California site that plans to open by then. The situation could improve for a dozen Midwestern states one year later, when waste sites are scheduled to open in Nebraska and Illinois.

But for most states, new waste sites will probably not be built before the 1996 deadline. Consider Massachusetts. In 1987, then-governor Michael Dukakis decided his state would dispose of LLRW on its own. But today the commonwealth isn't close to starting the search for a disposal site. That politically and emotionally charged process could easily take three or four years, according to Carol Amick, executive director of the state's Low-Level Radioactive Waste Management Board. Tack on what experts say could be another four years for design and construction, and the earliest a new site could open would be 1998.

It's tough to say when generators in various states will be able to dispose of their low-level wastes. Citizens' groups are battling all the proposed sites. A federal judge recently vetoed the site planned for Texas, sending that state back to the drawing board. Michigan and New York have sued the federal government over the LLRW Policy Act's constitutionality.

Ongoing negotiations among states could lead to new multi-state disposal arrangements. Such a contract could provide a reasonable solution to Massachusetts' disposal problems. Without such a solution, however, MIT will store low-level waste on its Cambridge campus, in a building where the material is already kept for short periods. Massé plans to expand the space so it can hold seven years' worth of waste. To minimize handling, everything will be packaged, ready for eventual shipment.

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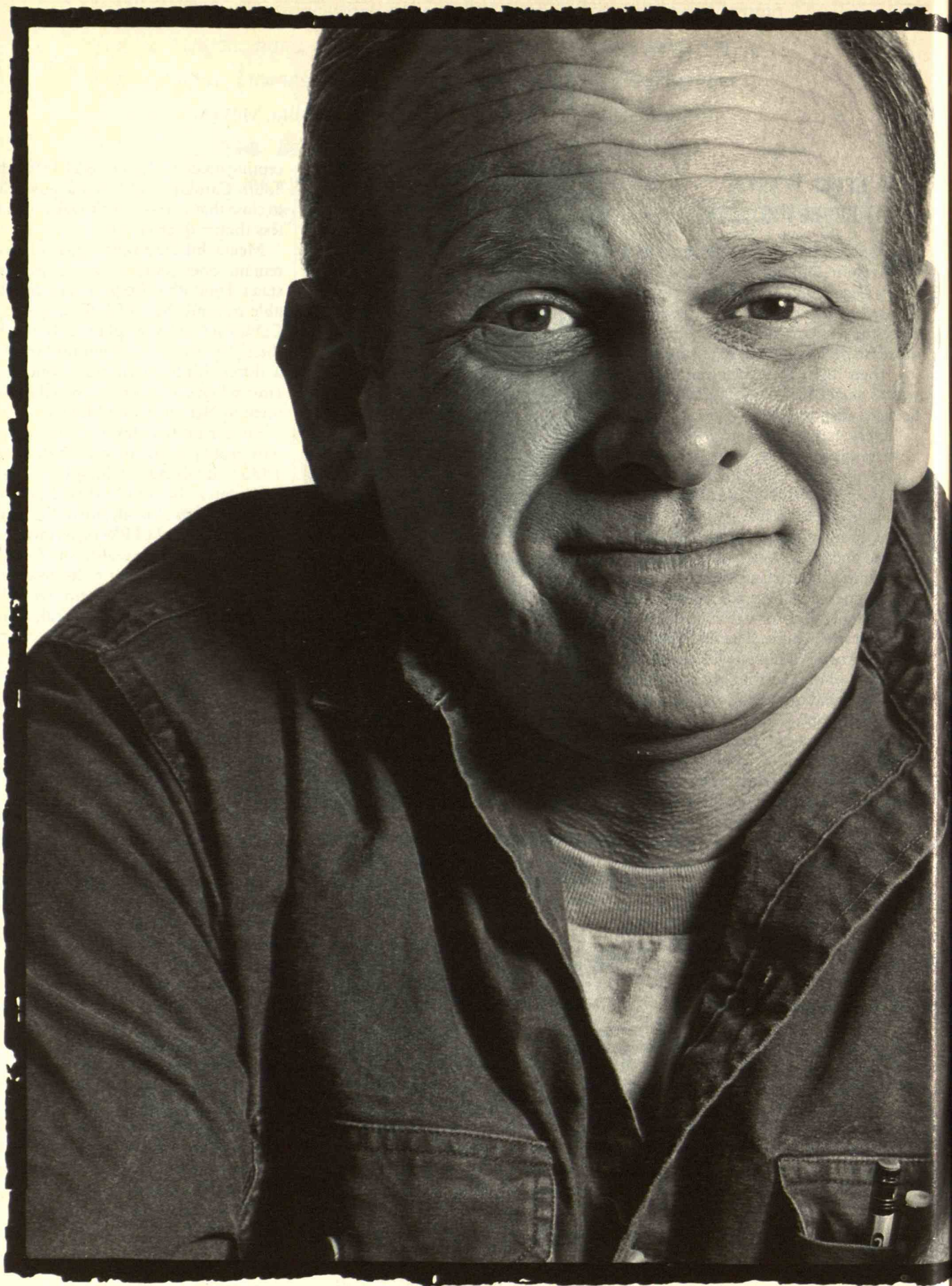
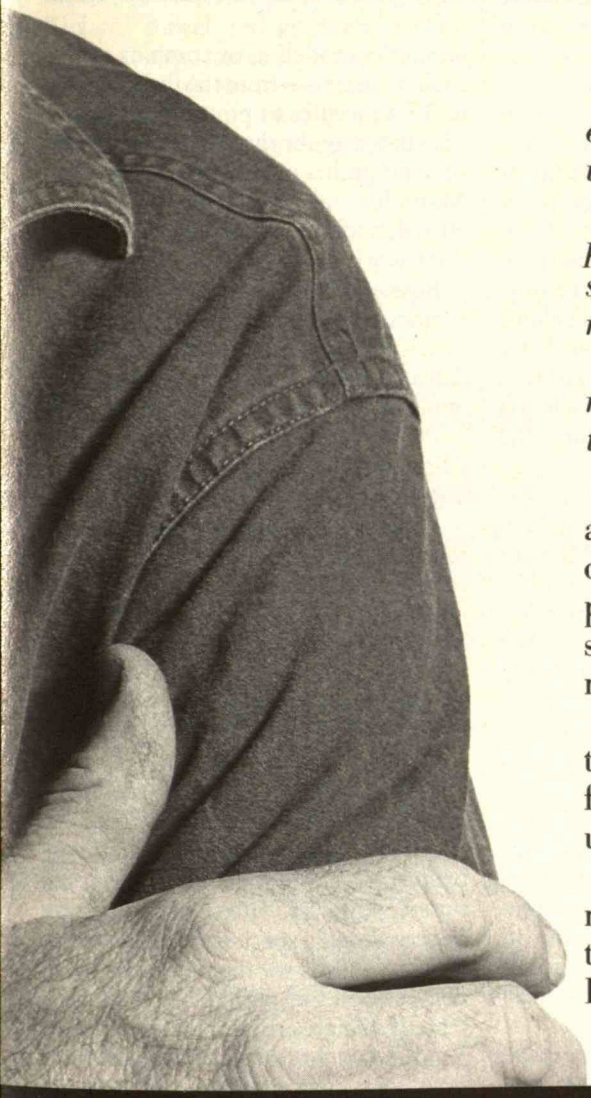
PHOTOS: COURTESY OF MIT RADIATION PROTECTION COMMITTEE



"The idea of computers in the factory used to scare the daylights out of me. Now I run one."



"I figured I'd get burned either way—computers show up and I get fired, or computers don't show up and the plant closes down.

"But what happened is, they retooled the plant and while that was going on they sent me to school, to an IBM-sponsored course at the community college.

"Here are two things I learned. I learned a new job that's better than my old one. And I learned that our plant won't be boarded up any time soon."

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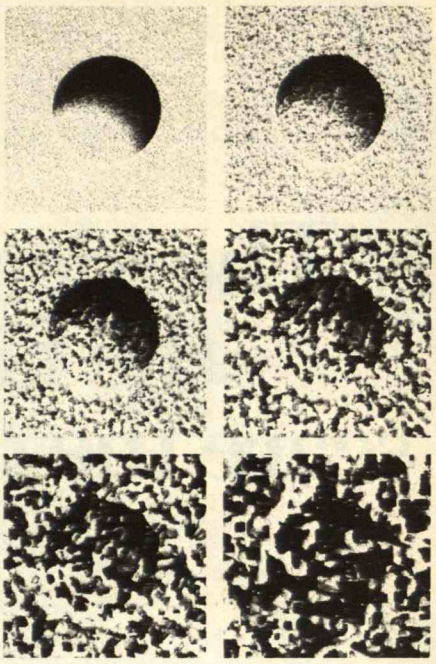


Even if every state manages to find a place to dump low-level radioactive wastes by 1993, the problems may not all be solved. According to current plans, as many as 13 disposal sites could be built. That's too many, Massé says, because producers have cut the amount of waste they generate by almost two-thirds since the 1980 law was written. With too many sites, some could fail to get enough waste to generate the income they need for effective operation. As a result, they might employ too few staff for proper monitoring, according to Massé.

"Three or four good sites would probably be enough to last for another 50 years or so," says Scott Saleska, a staff scientist at the Institute for Energy and Environmental Research.

Massé says that disposal costs associated with the new sites may pose another dilemma. A site can cost between $20 and $70 million to build. All of this cost will be passed along to generators. Pennsylvania and Nebraska, for example, are predicting charges of $8,000 to $15,000 for each 55-gallon drum sent to their proposed sites, according to Massé, who has seen prices rise from $30 a drum a decade ago to $750 today. While the estimated costs could change, partly based on how many states send LLRW to a site, Massé worries that high prices might lead unscrupulous producers to dump their wastes illicitly.

Still, the new sites could have environmentally safer conditions than the present ones, according to Saleska.

Low-level radioactive waste disposal is more a political problem than a technical one, experts agree, and will require political solutions. Redefining the term "low-level waste" would be a start, says Saleska. It is now a catch-all phrase for material that is neither high-level waste from nuclear power plants nor waste from uranium mining and nuclear weapons production. LLRW includes both material that decays to natural background levels rapidly—after 12 years, say—and that which breaks down much more slowly—after 500 years. Saleska says it would make more sense to define radioactive wastes as short-lived or long-lived, and dispose of the latter in a federal repository. That would significantly reduce the needed amount of low-level waste storage.

Somehow, experts say, there has to be a way to build a handful of national low-level waste disposal sites without placing the environmental burden solely on the host states. In the meantime, "this is an incredibly messy situation," says Massé. "My colleagues are scratching their heads wondering how we ever got to this point." ■

By P.J. SKERRETT, a free-lance science writer

SPEEDIER COMPUTING

By summer's end, a group at MIT's Laboratory for Computer Science expects to have built a new, faster computer. Equipped with the same number and kind of chips as the best supercomputers on the market, the machine could run as much as 1,000 times faster on certain problems. Research scientists Norman Margolus and Tommaso Toffoli say such a machine could be built at the same cost as today's conventional supercomputers.

The design for the computer, which Margolus and Toffoli call a "cellular automata machine" (CAM), consists of an array of processors, each of which has the same capacity as that in a personal computer. Each processor in the CAM operates according to a simple set of digital rules that instruct it to behave in a way according to what a certain number of its neighbor processors are doing. The focus is on capturing the essential interactions in a physical process. This approach contrasts with the one used for conventional parallel-processing supercomputers in that it avoids any attempt to represent numbers fed into the computer, which can require complicated programs.

The new computer, the designers say, should be able to tackle problems that entail the modeling of complex physical interactions—from the fluid dynamics of molecules to population growth of urban neighborhoods to the shifting of sand grains in soil erosion. In fact, Margolus and Toffoli became interested in developing the machine because of their work as physicists.

Research funding for the cellular automata machine came from the National Science Foundation and the Defense Advanced Research Projects Agency. Sun Microsystems, which hopes to marry the approach to its most sophisticated computer workstations, has provided engineering help.

Once built, Margolus and Toffoli's machine will be in for a strenuous trial by the scientific community, notes John Gage, director of the science office at Sun Microsystems. The models the machine generates will have to reflect the same reality as that described by accepted computation methods.

Furthermore, the commercial and scientific roles of cellular automata machines have yet to be defined. At Thinking Machines Corp. in Cambridge, a leading maker of supercomputers, physicist Bruce Boghosian says he sees a highly specialized function for CAMs. "I don't see them necessarily as competition but perhaps as a component of a single process," he comments. Boghasian believes that number-crunching will remain important in

ILLUSTRATIONS: COURTESY OF TOMMASO TOFFOLI

solving problems, so traditional supercomputers will continue to have a role. "If we could figure out how to make [these different computers] communicate with each other, they could make good music together." ■

By JOHN PARKER, a free-lance technology writer

PLUTONIC AFFAIRS

For more than 60 years since its discovery, Pluto defied the probings of earthbound astronomers. But in the late 1980s, MIT planetary scientist Richard Binzel and graduate student Eliot Young, among others, began offering details about the ninth planet's appearance. By measuring light when Pluto's moon Charon was eclipsing the planet, they discovered that Pluto appears brighter and bluer at the poles than at the equator. (*See "The Seasons of Pluto," TR July 1989.*)

Binzel and Young, who are creating a map of the planet's surface, have now found that Pluto's south pole is especially bright. Why should that be so?

Traditional thinking would hold that, if anything, the south pole should be darker. Pluto lies on its side as it circles the sun, and during the last century the south pole was exposed to continuous sunlight. That should have caused the pole's covering of methane ice to evaporate, exposing a darker surface.

Binzel thinks the explanation might be that nearly a million years ago, Pluto had a different orbital orientation—one in which the north pole received direct sunshine when the planet was closest to the sun. At some point during that distant epoch, Binzel believes, the combination of continuous sunlight and the nearest approach to the sun caused methane ice at the north pole to evaporate. Methane gas could have flowed toward the shadowed south pole and frozen there, he suggests. The accumulation of methane frost could account for that pole's particular brightness.

Once their map is finished, Binzel says, it should show at least as much detail on Pluto as we see on our moon with the unaided eye. That should equal or better the resolution expected from NASA's Hubble Space Telescope once its flawed mirror is fixed. Binzel and Young are hoping that Hubble's images will confirm their findings. ■

By ANDREW CHAIKIN, a free-lance science writer

"IT WAS A REAL BLESSING," Frances Vaughn said after volunteers from the Christmas in April program gave her house a face lift.

"A whole slew of people gave up their weekend to help me. They fixed my back porch. Painted every room. Gave me a stove. They even put a brand-new roof on. I could've kissed every one of them."

This neighborly love is being rekindled all over America, thanks to Christmas in April.

Thousands of people from all walks of life are banding together to help the poor, the elderly, the handicapped.

By repairing homes, these caring volunteers are doing more than painting and hammering.

They're restoring dignity, hope and pride.

"TODAY I fell in LOVE with TWENTY perfect STRANGERS."

FRANCES VAUGHN

Washington, D.C.

The launch of Christmas in April☆USA was made possible through the commitment of many people and corporations, including a grant from the Toyota USA Foundation. We're proud to say we've been a supporter from the very start.

As a result, the national body has been able to help more communities start local programs. (The number has grown from 13 to 52 in just over two years.)

Frances Vaughn is certainly thrilled the folks around Washington rallied behind Christmas in April.

In fact, she would have jumped through the roof with joy if it hadn't just been repaired.

TOYOTA

INVESTING IN THE INDIVIDUAL

Trends

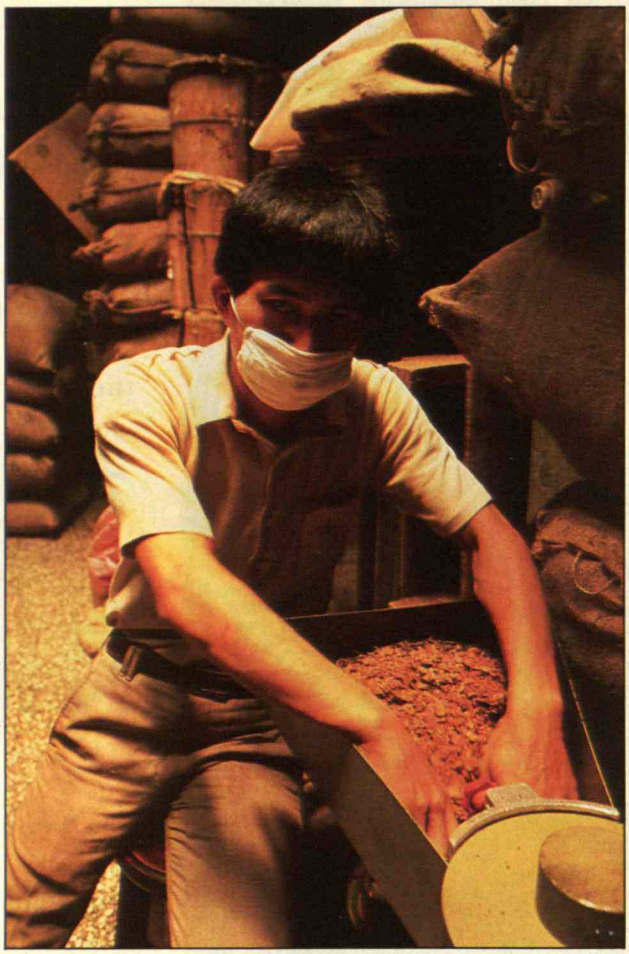
Polluting Paradise

In 1517, Portuguese sailors dubbed Taiwan Ilha Formosa—beautiful island. The name fit. Crystal waters plunged from soaring mountains to the sea. Tropical, semi-tropical, and temperate flora carpeted the South China Sea island.

Travel writers still celebrate that beauty, but not everyone shares the sailors' experience. In the capital, Taipei, pedestrians wear masks to keep gritty air from their lungs. Factories pollute groundwater and topsoil. Agriculture has moved up from the plains, deforesting the hills. Most rivers, at least in stretches, are seriously polluted.

While an awareness of environmental problems hasn't supplanted an official growth-at-any-cost strategy, ecologists, opposition politicians, and even some members of the ruling party say they are ready to change course. "We are approaching a point at which environmental degradation . . . detracts from economic productivity," suggests Yun-Peng Chu, an industrial economist at the National Central University and coauthor of *Taiwan 2000,* a groundbreaking study of the ecological aspects of development.

No one denies Taiwan's impressive growth. Between 1960 and 1980, the economy expanded about 10 percent per year. The pace is slower now but still a healthy 5 percent. At $7,990, the yearly per capita GNP is Asia's fourth highest, after Japan, Hong Kong, and Singapore. The island exports $70 billion worth of products annually, maintains an $11 billion trade surplus, has no foreign debt, and holds inflation to under 5 percent a year. Infant mortality is 5 per 1,000 births, a better record than that of the United States or Canada, while 91 percent of Taiwanese are literate.



Taiwan's impressive economic growth has been accompanied by little freedom, oppressive working conditions, and ecological decay. Taipei's air is so foul that some people wear masks for protection.

Taking credit for Taiwan's status as one of the few "newly industrialized countries" (NICs) is an autocratic, anti-communist regime. But its critics say the regime is also responsible for the accompanying problems: little freedom, oppressive working conditions, and ecological decay.

For example, to stimulate growth, the government gives breaks to polluting industries. Hsin-Huang Michael Hsiao of the National Taiwan University and Lester Milbrath of the State University of New York at Buffalo point to the petrochemical industry, which gets low-cost raw materials and easy access to construction and operating permits. Yet the industry has leaked hydrogen cyanide, PCBs, chlorine, and other toxins into the ground and water. According to Hsiao and Milbrath, government leaders consider the petrochemical industry "so essential to prosperity that they must encourage its growth despite its failure to clean up its emissions." Between 1952 and 1981, the number of chemical plants rose from 5,622 to 62,474.

Growing Pains

Chemical factories aren't the only culprits. Acid rain from smokestack industries fouls the air, imported and domestically produced heavy metals taint rice paddies, pesticides pollute water, and coal-fired generators cloud the sky. Taiwan's conditions are comparable to Eastern Europe's better known problems and are far worse than those found in most of the United States. And since the government disperses industries around the island, few regions escape unscathed. Edgar Lin, an ecologist and geneticist at Tung Hai University, has described the impact of Taiwan Petroleum on one small southeastern town: Hou Jin, he told the Taipei magazine *Bang,* "has been polluted so seriously that the effluents in the water can be ignited."

Two recent cases involving "naphtha-cracking" facilities illustrate how reluctant officials are to place ecological concerns on a par with economic ones. These plants break down the petrochemical naphtha into such substances as ethylene, which is used to make plastics. The process begets numerous hazardous wastes that Tai-

wanese factories have long released into the ground and water. This problem is not unique to Taiwan. In 1990, Texas fined Formosa Plastics close to $250,000 for environmental violations at a similar plant.

Despite local opposition, the government gave the China Petroleum Corp., which the Taipei government owns, permission to construct the island's fifth naphtha-cracking plant. It is also supporting the efforts of Formosa Plastics Group, a private firm, to build a sixth. Officials even courted Formosa Plastics when it considered locating the plant in China.

The decline of Taiwan's ecosystem has begun to generate significant public reaction. "People in Taiwan generally feel that environmental quality [is] not good," Hsiao has concluded after surveying Taiwan's population. "People tend to be rather pessimistic about the future trends of environmental quality."

Other surveys reveal Taiwanese to be willing to sacrifice some growth for a better environment. In one case, 59 percent of the respondents favored environmental protection over economic growth; in another, 65 percent favored preserving nature over using nature to produce goods. These attitudes have manifested themselves most prominently in electoral victories for environmental causes and protests against nuclear power. Public outcry has even forced industries and government to drop plans to locate certain plants in Taiwan. In one case, protests by residents of Lukang led Du Pont to seek another location for a $160 million tritium-dioxide plant.

However, Taipei has yet to give priority to ecological issues. Government critics, who commonly describe the Environmental Protection Agency established in 1983 as toothless, believe Taiwan must accept slower growth if the island is to protect the quality of life that development has made possible.

The key may be democracy. Other economies that advanced under authoritarian regimes face a similar ecological plight. And while Eastern Europe's troubles are better known than those facing the NICs, Walden Bello, author of *Dragons in Distress: Asia's Miracle Economies in Crisis,* sees a connection. "In each case you had a command economy," he says. "Because there was no democracy, the people making decisions were insulated from the complaints of the population. They did not hear what people were saying about the decay of their environment." ■

By JAMES B. GOODNO, author of The Philippines: Land of Broken Promises *(Zed Books, 1991)*

Government critics, who commonly describe Taiwan's Environmental Protection Agency as toothless, are beginning to question growth-at-any-cost economic development.

Tree Rings of the Deep

Scientists have turned soothsayers of the sea and learned to read the life history of fish in a most unlikely spot—ear bones.

Researchers have come to understand patterns in the size, shape, and composition of fish otoliths, six rock-like bones that are commonly called "ear stones." By joining these patterns to complex analyses of annual and daily growth rings, scientists might read a fish's sex, food, and the actual birth date. How often a fish spawned, the temperature of the water it swam through, its passage from fresh- to saltwater, and even the number of times it was caught and thrown back may also be inscribed in ear stones.

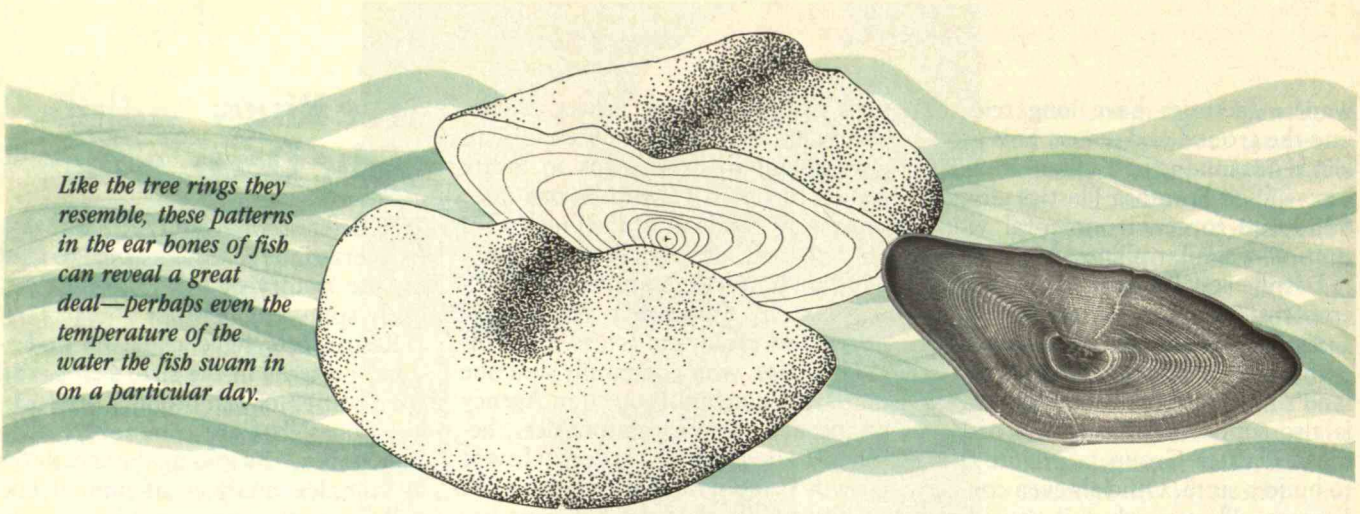
Two recent advances, one biological and one technological, have generated an intense effort to decode the secrets of otoliths. While Norwegian researchers in the early part of the century noted yearly growth rings in fish ears, daily rings are so fine—ranging from one-fifth to one-fiftieth of the width of a human hair—that biologists long missed their significance. Only in 1971 did Yale University geologist Giorgio Pannella, working with fossilized otoliths, suggest the existence of daily rings.

Pannella's hypothesis is now largely accepted—at least for the first year of life—but the process that generates ear stones remains mysterious. It begins while a fish is an embryo, when the bones grow as calcium-carbonate deposits mixed with small amounts of protein. The result, says University of South Carolina fish biologist John Dean, is "just a piece of rock, just limestone."

The rock-like nature means that, once laid down, growth lines last forever, and the bony rings can be read as historical indicators in part because of the color and width of these rocks.

"The width of the growth ring is roughly proportionate to how much

PHOTOS: ALEXIS DUCLOS, CLAUDE FRANCOLON/GAMMA LIAISON



Like the tree rings they resemble, these patterns in the ear bones of fish can reveal a great deal—perhaps even the temperature of the water the fish swam in on a particular day.

a fish grew in a day," explains Steven Campana, a researcher with the Canadian Department of Fisheries and Oceans in Halifax, Nova Scotia. "Although you can't see what is happening to fish swimming in the ocean on, say, March 14, you can look at the growth ring afterward and start comparing that to water temperature or wind or whatever."

Even more important is the chemical make-up of the rings. John Kalish of the New Zealand Fisheries Research Centre in Wellington has chemically analyzed salmon otoliths and compiled a daily record of the fish's travels by measuring the concentration of tritium, a form of hydrogen found in higher amounts in seawater than in freshwater. Tritium rates in the rings are high for eggs inside a sea-going mother. The rates decline when the mothers go up freshwater streams and rise again when a hatched fish returns to the ocean.

Finding chemical signatures—including those for particular foods—rests on advances in technology. "In the not-too-distant future, laser beams assisted by mass spectroscopy will be able to identify individual atoms," Campana predicts. "That will tell us the temperature of the water and perhaps provide the basis for a composition analysis that will tell us which water the fish was swimming through that day."

While of intrinsic interest to fish scientists, decoding these "tree rings of the deep" promises to shake up the politicized world of fish quotas. If ear stones yield reliable data, they could lead to the Holy Grail of those who manage fish stocks: the ability to predict watery baby booms and busts. Wild swings in survival rates mean that one year's cod stock can be up to 10 times higher than the previous one. Environmental information embedded in daily growth rings may suggest what conditions trigger ups and downs.

Moreover, by birth-dating fish from ear stones, fisheries managers can count their stock in many ways. Is most of a school comprised of elderly fish? Is it a mixture of big, young fish from one year and small, older ones from others? Were the fish spawned in one place or several?

Equally tantalizing are "checks"—deep, narrow, and dark marks that appear on otoliths when a fish is stressed. For example, hormone changes during spawning are believed to produce a noticeable yearly check. Storms, food shortages, daily or seasonal temperature changes, and even sudden frights might create characteristic checks. Campana says he can read in these the day a fish was caught.

Even without knowing the precise signature of all stressful events, scientists can create check "brands" in otoliths. Edward Brothers, a fisheries consultant in Ithaca, N.Y., treats trout eggs to daily temperature changes of five to eight degrees centigrade. This leaves a pattern of dark and light, wide and thin checks. By carefully manipulating the temperature, Brothers produces the otolith version of Morse code dots and dashes. He has produced rings that read "LT" for lake trout and "GLFC" for Great Lakes Fishery Commission. This makes it easy to identify fish raised in hatcheries.

Someday, Campana believes, computer analysis of otolith shapes may help officials outwit poachers. Together with colleagues at the Ontario Ministry of the Environment, he has examined 13,000 cod otoliths to learn to correlate shape to spawning ground with an accuracy of 80 to 90 percent. "If a foreign fisherman says he caught a cod off, say, Nova Scotia, we can look at the otolith shape and determine whether he is telling the truth."

While technical problems to widely applying the knowledge of otoliths remain—it takes an hour to treat some samples and it's hard to discern daily lines, for example—a fish-ear revolution may be at hand. "My metaphor is that they are like the Rosetta stone," says Dean. "Once we cracked that, we were able to read the entire written cultural history of Egypt. Otoliths are the Rosetta stones in the life of fish." ■

By STEPHEN STRAUSS, a contributing writer to Technology Review *and science writer for the* Toronto Globe and Mail

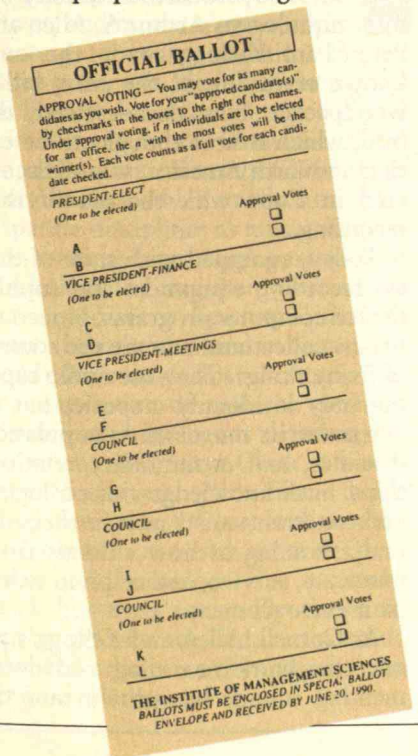
ILLUSTRATION: KITTY JOHNSON; PHOTO: BILL HAAKE

A Choice, Not an Echo?

In most U.S. elections, voters select one of two or more competing candidates. But the members of the Institute of Electrical and Electronic Engineers (IEEE), the Mathematical Association of America, and a handful of other societies can cast ballots for several people at once. They cast "approval votes" in a procedure proponents argue most efficiently expresses the majority's will.

With approval voting, voters may select one or more people but cast only one vote per candidate. Thus, voters "approve" a few nominees, a single favored choice, or even all the aspirants for a position. The candidate with the most votes—the highest approval rating—wins.

"Voters can more adequately express themselves with approval voting," says New York University political scientist Steven Brams, a leading advocate of the procedure. In particular, he says, this is true when several people are running.



OFFICIAL BALLOT

APPROVAL VOTING — You may vote for as many candidates as you wish. Vote for your "approved candidate(s)" by checkmarks in the boxes to the right of the names. Under approval voting, if *n* individuals are to be elected for an office, the *n* with the most votes will be the winner(s). Each vote counts as a full vote for each candidate checked.

PRESIDENT-ELECT (One to be elected) — Approval Votes
A ☐
B ☐

VICE PRESIDENT-FINANCE (One to be elected) — Approval Votes
C ☐
D ☐

VICE PRESIDENT-MEETINGS (One to be elected) — Approval Votes
E ☐
F ☐

COUNCIL (One to be elected) — Approval Votes
G ☐
H ☐

COUNCIL (One to be elected) — Approval Votes
I ☐
J ☐

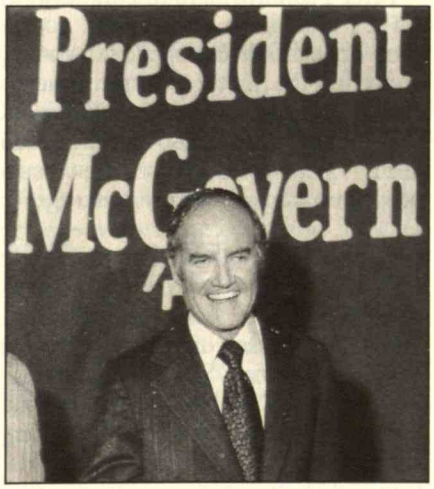
COUNCIL (One to be elected) — Approval Votes
K ☐
L ☐

THE INSTITUTE OF MANAGEMENT SCIENCES
BALLOTS MUST BE ENCLOSED IN SPECIAL BALLOT ENVELOPE AND RECEIVED BY JUNE 20, 1990.

For example, in New York's 1980 Senate race, Alphonse D'Amato won with 45 percent of the vote. He defeated Elizabeth Holtzman, who garnered 44 percent of the vote, and Jacob Javits, with 11 percent. But most Javits supporters told polls they preferred Holtzman over D'Amato. An approval vote probably would have sent her to Washington. Similarly, George McGovern won the largest sliver of the Democrats' fractious 1972 presidential primary but, lacking a broad following, he lost disastrously in November.

Brams, who says "I have a bias for consensus," cites such instances as evidence that traditional voting can be undemocratic. He believes approval voting is more likely to find the consensus candidate. Moreover, he argues, approval voting gives undecided voters more choice, lending greater legitimacy to the final results.

Several professional societies go along with that. In 1987, the Institute of Management Sciences adopted approval voting, while the Mathematical Association of America also began electing its president and two vice-



"Approval voting" may give consensus candidates preference over more extreme ones. Could it have prevented the Democratic Party's disaster in the 1972 presidential election?

PHOTO: UPI/BETTMANN ARCHIVE

presidents through approval voting. At the National Academy of Sciences, an approval ballot comprises one step of a multi-stage process for electing new members.

Despite the growing acceptance of the technique at scientific societies, approval voting has detractors. "I think approval voting is unfair," says

Merril Buckley, president-elect of the 300,000-member IEEE, who won in a 1990 approval vote. "Approval voting gives stronger weight to people voting for more than one candidate," he explains, all but guaranteeing that "outsiders" will lose.

The late Irwin Feerst, a controversial candidate for the IEEE presidency, also decried approval voting, calling its use a move to squelch issues he and his supporters raised. He advocated that the institute tackle issues of interest to the "working" engineer, such as pensions.

Feerst's critics say he was a fringe candidate who wanted to transform the IEEE into a union. In fact, the institute board first considered approval voting in 1984. Interest grew two years later following a near-win by Feerst. The board adopted approval voting in 1990—and Feerst finished fourth.

The 1988 winner, Carelton Bayless, a retired Pacific Bell engineering manager, sees it differently. While admitting that approval voting undercuts splinter candidates, Bayless doesn't believe it always favors the status quo. He cites Buckley's 1990 victory running as an outsider in a field of five, of whom the board selected three.

In at least one public election, approval voting failed to work. In November 1990, Oregon voters considered five initiatives about public-school financing—and sent a confused message to the legislature. The voters signaled their strong dissatisfaction with the existing method of financing schools solely through property taxes, but none of four alternatives (including sales-tax or income-tax levies) received the required 50 percent of the votes. "The results were very inconclusive," says state representative Carl Hosticka, an architect of the voting scheme. He believes voters had too many choices. "Now we're back to square one."

That is an inherent flaw in approval voting, says Northwestern University mathematician Donald Saari. He argues that approval voting breaks down when voters must weigh complex or conflicting motivations or when they vote insincerely.

In some cases, Saari says, "a small group of people can influence" an election—exactly the problem with traditional pluralist voting. Suppose 10,000 citizens had to choose among Alicia, Manuel, and Carl. Suppose 9,999 of them consider Alicia superb and vote for her. They also like Manuel, though less strongly, and cast a second vote for him. No one likes Carl, who votes against Alicia by casting a ballot for Manuel. Manuel wins, 10,000 to 9,999.

Peter Fishburn, a mathematician at AT&T Bell Labs and Brams' co-author on a book on approval voting, concedes the method is sensitive to such strategic manipulation. But in an actual election, he says, "there are too many variables to allow you to succeed in manipulating the outcome."

Barbara Bailar, executive director of the American Statistical Association, agrees. Problems with approval voting may exist "in a mathematical sense and never arise in a real situation." On balance, she thinks approval voting has the most benefits and fewest deficiencies, and her association now uses it for all offices. ■

By TOM KIELY, a contributing writer to Technology Review

Listening to the Birds

In 1935, Cornell University ornithologists Arthur A. Allen and Peter Paul Kellogg made the only known recording of the ivory-billed woodpecker. Four decades later, the bird, which is now thought to be extinct in North America, was rediscovered in Cuba with the aid of that recording.

Today, equipped with state-of-the-art recording equipment and sophisticated computer programs, bioacousticians collect and analyze the sounds of living things. They use audio tapes not only to identify a species but to determine its movements, population densities, and evolutionary relationships. Such knowledge aids ecologists and conservationists as it furthers the understanding of how animals communicate, survive, and respond to human encroachment.

At Cornell, Allen and Kellogg's pioneering work recording and documenting sounds has grown into the

ILLUSTRATIONS: COURTESY OF SOUTHERN EXPOSURE; DOVER PUBLICATIONS

Armed with recordings made in 1935 of the sounds of ivory-billed woodpeckers, bioacousticians rediscovered the bird in Cuba four decades later.

world's largest collection of wildlife noise, the Library of Natural Sounds. Recordings include the utterances of Rwandan mountain gorillas, a newly discovered Peruvian parrot, and more than half the world's estimated 9,000 bird species. The collection contains over 65,000 recordings, with 3,000 to 4,000 added every year.

However, until recently, scientists rarely sought out this vast library. Instead, the recordings were consulted by bird enthusiasts, teachers, movie producers seeking natural sounds for special effects, and museum and zoo curators wanting to build realistic exhibits. Three years ago, the desire to exploit the library as a scientific resource led Cornell to create the Bioacoustics Research Program. Director Christopher Clark has assembled a team from such disparate disciplines as music, linguistics, ornithology, engineering, and psychology to bring their perspectives and expertise to bear on questions about the role of sound in nature.

"We have musicians who study music composition or cultural variation in music and biologists detailing exotic organisms," says Clark, a biologist and engineer. "It's like a blind date," he muses. "What do these people have to say to each other?" Quite a lot, as it turns out. For example, Clark has used essentially the same techniques to track and census arctic bowhead whales as the military uses to track missiles.

Reflecting the program's origins, several of its associates specialize in birds, particularly in the tropics. Working mainly in Africa, the husband-and-wife team of Jennifer Horne, a research fellow at the National Museums of Kenya, and Lester Short, bird curator at the American Museum of Natural History, listen to barbets, toucans, and honey guides, a group of birds related to woodpeckers. Short was also a member of the team that found the ivory-billed woodpecker in Cuba in 1986.

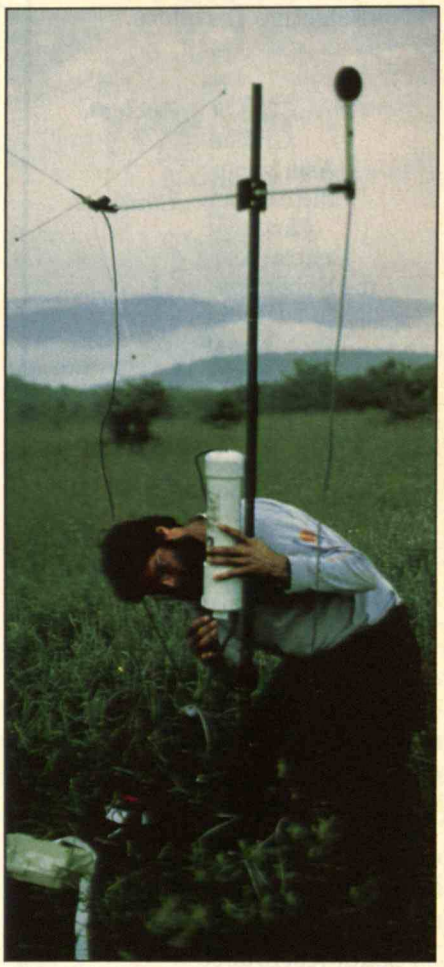
Working long days in the field, Horne makes recordings that Short later edits and analyzes in the lab. He constructs sonograms, which visually display volume, pitch, frequency, and other characteristics of bird sounds. According to Short, "eyeball comparisons" of sonograms can answer questions like which birds are related and how close the relationship is.

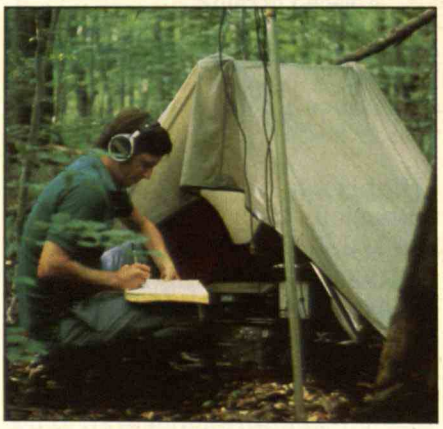
Analysis of bird sounds can also reveal the unexpected. "When you study them intricately, you find out some startling things," says Short, "like the fact that females may sing. Usually people hear a song, and they assume it's a male bird."

Count 'Em While You Can

Quantitative data on species can reveal the effect of deforestation and the resulting loss of bird habitats. This is a high priority for the Cornell program, says ornithologist and field recordist Bret Whitney. The thousands of tapes will form a data base that scientists can draw on to establish conservation priorities. "We can't protect all of it," Whitney notes, so an area that recordings show has many species could get precedence.

Whitney travels to South America several times a year to make recordings in remote and unprotected tropical rainforests. He captures the sounds of myriad forest birds as they announce their territory, contact mates, issue alarm calls, and interact with their own and other species.





Cornell researchers John Bower (top) and Christopher Clark (bottom) study birds in Ithaca's Sapsucker Woods with an array of microphones.

PHOTOS: CHRISTOPHER CLARK, JOHN BOWER

While Whitney and Horne record with one microphone, Clark and others have experimented with four to eight microphones arranged on the corners of a square. The quadraphonic array collects data more accurately than a human observer when dense foliage makes identifying and counting dozens of similar-sounding species especially difficult.

Back at Cornell, a new recording is compared with library tapes to finish the identification process started by the field scientists. Sometimes the computer can make a firm identification. However, often it can identify only a range of possibilities, leaving the final say to a limited pool of experts. Thus, the bioacoustics program is developing a computer system that will recognize patterns and identify sounds on its own, using criteria provided by the experts.

With recordings from the quadraphonic arrays, computers can also reveal the density and diversity of bird species. This makes it possible to map the locations and movements of many species simultaneously. Such data is potentially invaluable for countries with endangered tropical forests. "If we're going to make intelligent decisions about destroying or preserving millions of hectares of rainforest," says Clark, "they must be based on knowledge."

In parts of South America, the techniques and data are already being applied. In Bolivia, a bioacoustics program associate is working with teams sent by Conservation International to survey sensitive areas. These teams are helping the Bolivian government set aside relatively pristine tracts of land that have high species diversity.

"We are facing massive extinction in certain areas of the globe," says Jennifer Horne. "We've got to learn what we can, while we still can." Bioacoustics is one way to do that. ■

By TRACEY COHEN, a free-lance science writer in Highland Park, N.J.

Made of Muscle or Bone

Surgeons can perform phenomenal feats. They can replace clogged coronary arteries with blood vessels from the leg. They can reconnect minuscule capillaries, tendons, and nerves to reattach severed fingers. They even refashion parts of intestines to create new bladders.

But surgeons find it extremely difficult to reconstruct complicated bones such as the jawbone or the framework of the inner ear. And only rarely can they replace large segments of bones that have been lost to a disease or major injury.

The challenge stems from the nature of bones. Unlike other types of tissue, bones with one normal shape cannot be reworked into other shapes. Nor can doctors move large bones from one part of the body to another without severely disabling a person.

Roger Khouri and David Brown, plastic surgeons at Barnes Hospital in St. Louis, Mo., are beginning to overcome these obstacles by creating substitutes for complex and long bones. These stand-ins come not from medical laboratories or the designs of bioengineers. Rather, the body itself produces them, as surgeons learn to transform muscles into bones.

Khouri points out that existing treatments for bone defects are all short-term and limited. Surgeons replace some diseased joints with plastic or metal prosthetic implants, but artificial hips or knees steadily loosen and must be reconstructed every few years. For small defects, physicians can insert bone chips. However, it takes months for the chips to incorporate into the remaining bone segments, and this approach doesn't help people who need bone replacements the most—those who have lost a bone to cancer or an accident and do not have enough remaining blood to nourish new bones.

Actually, the idea of making bones

from muscle is not as strange as it may seem. Muscle, bone, fat, blood vessels, and bone marrow all develop in human embryos from the same loosely organized tissue, and scientists have been trying for years to isolate the factors that make these amorphous cells grow into highly specific body parts.

Ten years ago, Joseph Murray, the 1991 Nobel Prize winner for medicine, reported using a matrix of bone chips to get certain skull parts to grow in children who were born without them. Although Murray and his team often achieved excellent results, they failed in some cases because of a host of problems with the bone material. A surgeon doesn't always have a reliable source of chips. Their purity and content vary from batch to batch. And it is difficult to obtain the chips from human sources, while material from animals doesn't work in people.

Taking another approach, in 1987, after years of effort, Harri Reddi of the National Institutes of Health in Bethesda, Md., isolated pure samples of the bone-inducing protein osteogenin from cows. This bovine osteogenin can make undifferentiated human tissue produce cartilage and bone. Nevertheless, few surgeons use osteogenin because it is hard to control. It could conceivably be sprinkled directly onto a defect, but the entire area might stiffen to bone if even a tiny bit fell on surrounding blood vessels and nerves.

ILLUSTRATIONS: ANDREAS VESALIUS

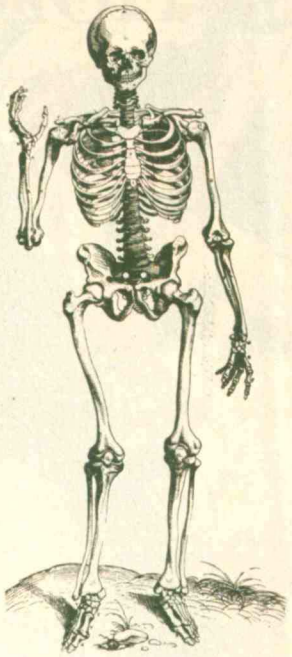
Precision Molds

Today, the Barnes Hospital plastic surgeons are circumventing that snag by prefabricating bones away from the actual site of a defect. Khouri and Brown take flaps of animal thigh muscles and place them in silicone rubber molds of the desired shape. The researchers coat the molds with osteogenin, close them, and implant them in the animal's abdomen. Two weeks later, the molds yield tiny bone segments contoured perfectly down to fine details.

At this early stage, it's difficult to say how the procedure would work in humans. However, a section of muscle might be taken from a patient and placed in a mold corresponding to the diseased or injured bone. After applying a coating of osteogenin to stimulate bone growth, the mold would be placed in the abdomen to provide a biologic environment for transforming muscle into bone.

Khouri and Brown have so far prefabricated bones from muscles in rats and other small animals but are years from attempting to repeat the process in humans for two major reasons. Osteogenin is available only in extremely small amounts, and the safety and effectiveness of the muscle-to-bone transformation must be tested on larger animals before trying it on humans.

Still, Khouri suggests that people with arthritic hips or knees and those with defects in large bones may one day use some of their own muscles to manufacture bony replacements. And muscle-to-bone reconstruction would benefit the people with the greatest problems. "The muscle would come



with its own nourishing blood supply," Khouri explains. "We could use an osteogenin-treated muscle even in patients who had lost a bone and its blood supply because of radiation injury or scarring or cancer."

Constructing bones from muscles could revolutionize the treatment of diseased or injured bones. After all, muscles are much more widely available than bones, and they are safer and easier to use to replace tissue. "You don't usually miss a muscle that is taken for a graft because so many muscles act in concert," Khouri notes. "If one is missing, the patient doesn't lose much function."

Finally, since muscles can be molded into precise shapes, the procedure would address the thorniest reconstruction task: replacing intricate bony structures such as those of the inner ear. "We may be able to put a muscle into a mold that is the right shape for the bone, put in some osteogenin, wait a few weeks, and have a ready-made replacement," Khouri says. ■

By KAREN SANDRICK, a free-lance writer in Chicago, Ill.

Nuclear Proliferation after the Cold War

A long-term strategy to slow the spread of nuclear weapons would address the conditions that create a demand for them.

ALMOST 30 years ago, John Kennedy warned that the ability to produce nuclear weapons could spread to 10 countries by 1970 and perhaps 15 or 20 by 1975. "Horizontal" proliferation to this extent did not occur in part because the world was divided into two power blocs. With the United States and the Soviet Union guaranteeing security within their alliances, other member states, aside from Britain, France, and China, felt little pressure to develop indigenous nuclear weapons programs. The acquisition of nuclear arsenals, especially by Germany or Japan, would have challenged the very structures of the great alliances and the uneasy equilibrium between them, and thus would have been vigorously opposed by Washington and Moscow.

The situation has altered in several ways at the end of the Cold War. On the one hand, the possibilities for U.S.-Soviet cooperation are enhanced. Neither superpower is likely to compromise in its opposition to proliferation because of concerns about its adversary, as the United States did when Soviet troops

ILLUSTRATION: GEOFFREY MOSS

BY GEORGE W. RATHJENS AND MARVIN M. MILLER

moved into Afghanistan. Then, because of an overriding desire for Pakistani help in opposing the invasion, the United States continued sending aid to Pakistan, although legislation would have normally required its end, given Pakistan's clandestine uranium-enrichment program. Similarly, U.S. concern that India might be driven further toward the Soviet Union also led President Carter to continue to supply the country with nuclear fuel. This was contrary to the sense of the Nuclear Non-Proliferation Act of 1978, which requires that such services be discontinued if non-weapons states do not accept international safeguards on all their nuclear facilities.

However, for the most part, the events of recent years have made it harder to stem proliferation through limiting access to critical materials and technology. The Soviet Union's capacity to affect political or military developments in the Third World is much diminished; so too is its interest, as its internal problems demand more attention. The United States has lost global influence in general because of its weakened financial condition, and in particular on nuclear matters because it is no longer the sole source of superior nuclear technology. Moreover, with a glut in uranium-enrichment capacity and strong competition from Western European sources, now neither superpower can credibly threaten to deny such services as leverage in dealing with would-be nuclear countries.

There are relevant technological changes as well. Of great importance regarding both nuclear weapons and missiles to deliver them is the fact that the number of potential suppliers is growing rapidly. Several states that are not members of the Nuclear Supplier Group or parties to the major agreements limiting exports of critical technologies have become important—notably China, India, Israel, Brazil, and Argentina. And with the end of the Cold War, an easing of the rules of the Coordinating Committee on Multilateral Export Controls (COCOM) is inevitable. Some increase in the leakage from COCOM member states of technology for both nuclear weapons and delivery systems is a likely consequence. Moreover, pressures to sell that technology—along with other military equipment—have increased in Western industrial nations as defense firms struggle to survive amidst shrinking government budgets for such hardware. A parallel situation prevails in the Soviet Union, where the need for hard currency is increasing as the means of getting it diminishes.

All this implies that many more states could soon gain access to first-generation nuclear weapons and the means to deliver them. Coupled with the inexorable spread of technology, these factors make us extremely skeptical about the prospects of preventing or significantly slowing the proliferation of nuclear weapons and of missiles and chemical weapons through policies of technological denial alone. Particularly for the long term, more attention should be focused on what can be done to reduce motivations to acquire such weapons.

Why Nations Want Nuclear Weapons

The record on motivations is mixed. For the United States, the Soviet Union, China, Israel, and Pakistan, security from military threats has been the primary reason to acquire nuclear weaponry. For Britain, great-power status has dominated, along with the desire to maintain influence, particularly with the United States. For France, the key factor has been a felt need for independence in security matters.

While India claimed it tested a nuclear explosive in 1974 for peaceful applications, it is widely believed that security concerns and the nation's aspirations to dominate the South Asian/Indian Ocean region politically and militarily were its primary motives. The claim that nuclear explosives could have important peaceful uses is even less credible now than when India made it and when Brazil and Argentina also asserted it as a rationale for their interest in such explosives.

There are, though, important reasons for believing that nuclear weapons aren't what they used to be. We have recently seen a clear demonstration of their limited relevance to deter war: Iraq attacked Kuwait notwithstanding the evident interest of the United States, Britain, and France in Kuwait as a source of oil. Presumably, Saddam Hussein believed these powers would make no effective response, nuclear or otherwise. The Egyptian-Syrian attack against Israel in 1973 and Argentina's seizure of the Falkland Islands are other examples of the point. The attackers would likely have been deterred had they thought a nuclear response at all likely, but with quite limited war aims, they discounted the possibility.

Moreover, since the mid-1960s, doubts have grown that the United States would actually use nuclear weapons to respond to a conventional attack against NATO. Henry Kissinger made the point eloquently at a Brussels conference on NATO in 1979. Though U.S. nuclear forces had protected NATO, he said, "The European allies should not keep asking us to multiply strategic assurances that we cannot possibly mean, or if we do mean, we should not want to execute because if we execute, we risk the destruction of civilization."

GEORGE W. RATHJENS, professor of political science at MIT, served during 1979-80 as chair of the interagency committee that managed U.S. participation in international studies of the relationship between nuclear power and nuclear weapons proliferation. He was also deputy to President Carter's ambassador-at-large for nuclear non-proliferation matters. MARVIN M. MILLER is a senior research scientist with the Department of Nuclear Engineering and the Center for International Studies at MIT. From 1984 to 1986, he was a Foster Fellow with the Nuclear Weapons and Control Bureau of the U.S. Arms Control and Disarmament Agency, and he is currently a consultant on proliferation issues for that agency, as well as for the Los Alamos and Oak Ridge National Laboratories.

Eisenhower once thought nuclear weapons might be used "as you'd use a bullet or anything else." But in the 1960s Kissinger told NATO not to count on a U.S. nuclear response to a conventional attack.

Recently, prominent establishment figures have suggested that NATO adopt a "no first use" policy on nuclear weapons. Similarly, former Secretary of Defense Robert McNamara and Solly Zuckerman, for many years science adviser to British prime ministers, have argued that nuclear weapons have no use other than to deter nuclear attack.

Going still further, questioning is intense, particularly among church groups, on the morality of wielding nuclear weapons even for that role. Presidents Reagan and Gorbachev have also expressed reservations about the morality of deterrence and discussed getting rid of major classes of nuclear weapons, or even of all of them. Some agreement has been reached on substantially reducing nuclear weapons stocks, with the Soviets accepting asymmetrical reductions. Clearly, the present leaders place a much lower value than did those of Brezhnev's day on having a few weapons more or less, so long as the totals number many thousands.

Thus, we have come a long way since Secretary of State John Foster Dulles enunciated the doctrine of "massive retaliation" and President Eisenhower could assert, with some aura of believability, "I see no reason that [nuclear weapons] shouldn't be used just exactly as you'd use a bullet or anything else."

Further, no doubt nuclear weapons have lost some of their cachet as indices of power and prestige, the more so as economic strength, exemplified by Japan and Germany, has become ascendant in international affairs, and military power counts for little if based on a sick economy like that of the Soviet Union. The desire for status and prestige may decline even further as a rationale for nuclear weapons with each passing year of nonuse, and as the economic power of the major nuclear states—the United States and the Soviet Union—erodes.

Still, universal acceptance of the view that nuclear weapons are useless remains a distant prospect. Nations will no doubt continue to both seek them and perceive them as a threat. In particular, nuclear weapons appear to be attractive deterrents or weapons of last resort for at least two nations confronting adversaries with superior conventional forces. Since its dismemberment in 1971, Pakistan cannot hope to match India in conventional forces. And Israel, in the absence of a political settlement of the Arab-Israeli conflict, faces the likelihood of also being outgunned conventionally.

Wherever a great imbalance in conventional capabilities is evident or in prospect, a weaker power that feels threatened will have an impetus to acquire nuclear weapons. Taiwan once manifested an interest in a nuclear capability to deter a much more powerful China. This might occur again in East Asia if Taiwan or another small country feels threatened by China—or Japan. It might even occur in smaller European countries, should they fear a rebirth of German revanchism or hegemonical aspirations. While the end of the Cold War and the disintegration of the Soviet empire may appear to make proliferation in Europe highly improbable, the idea commands a degree of attention that would have been bizarre a decade ago.

Also, if more nations acquire nuclear capabilities or even start down that path, potential adversaries might feel impelled to do so, too. Iraq's nuclear program was motivated by its desire to end Israel's nuclear monopoly in the Middle East. Had Iraq's nuclear program not been severely damaged as a result of allied bombing, Iran and Syria and perhaps even Egypt would have had strong motivations to move ahead themselves, whatever the balance in conventional forces between Iraq and each of them. Attempts to prevent nuclear proliferation by denying nations access to nuclear technology or by destroying a nascent nuclear infrastructure might delay the attainment of such capabilities. But military actions are unlikely to eliminate motivations, and may even reinforce them.

The best hopes for reducing the impetus for vulnerable states to acquire nuclear weapons lie in guaranteeing security. Any renascent German aggressiveness would presumably be muted by incorporating Germany into a politically strong European Community. Progress toward Korean reunification—some hope exists after 40 years—should dampen interest in nuclear weapons in both the north and south, and even without progress, a U.S. security guarantee can, for at least a few more years, slow South Korean impetus to respond to a North Korean nuclear program with one of its own. While South Africa's desire for nuclear weapons is largely inexplicable—its neighbors are weak, no state is likely to attack it, and nuclear might is hardly relevant to dealing with its Black population—the country's motivations should decline as it resolves its internal problems.

Unfortunately, in South Asia and the Middle East, the regions of greatest international concern, the task of eliminating or reducing the motivations for nuclear capabilities is much more complex.

PHOTOS: UPI/BETTMANN

The Special Problems of South Asia

Two years ago, there was some basis for optimism about resolving the disputes between India and Pakistan and helping slow or stop proliferation in South Asia. Benazir Bhutto's election as prime minister of Pakistan, which was well received in India, appeared to signal a move toward democracy. She was unenthusiastic about vigorously pursuing the nuclear weapons option, and she and Indian prime minister Rajiv Gandhi gave their approval to an agreement not to attack each other's nuclear facilities. At the same time, the Soviet withdrawal from Afghanistan was expected to mute U.S.-Soviet competition in South Asia, with its polarizing effect on Indo-Pakistani relations.

Since then, conflict over Kashmir has worsened. Also, Bhutto has had to defer to those strongly committed to Pakistan's nuclear program, and she and Gandhi have been forced from office. Ethnic and communal problems in both countries have worsened, and many people in each believe that the other is exploiting these, if not instigating them. While there is no consensus in either country about unilaterally implementing a full-scale nuclear weapons program, there is overwhelming support in both for keeping the option in case its rival goes ahead.

This similarity aside, Indian and Pakistani motivations to obtain nuclear weapons differ, and the lack of symmetry makes dealing with proliferation by simple agreements elusive. Reactions to proposals for a regional nuclear-weapons-free zone (NWFZ) are illustrative. A pact to simply foreswear nuclear weapons—even with verifiable compliance—would hardly satisfy either nation.

Pakistan officially favors such a measure, but the annals of diplomacy are replete with nations taking positions they could not live with, convinced that their adversaries would not agree. Thus, it is unlikely that Pakistan would agree to an NWFZ, given India's conventional military superiority and what Pakistan sees as India's hegemonical aspirations in South Asia.

Nor would an NWFZ satisfy India unless China were a party to it, since a major rationale for India's nuclear program is China's capability. Moreover, India would probably not agree to an NWFZ even with China included as long as the United States and other nuclear powers retain strong nuclear forces and clear propensities for projecting them into the Indian Ocean. Memories persist of President Nixon's sending the nuclear-armed carrier *Enterprise* to the Bay of Bengal in 1971 to warn India to limit its goals in the war with Pakistan. Since the Gulf War, Indians have expressed related concerns about the presence of U.S., British, and French forces in and around Saudi Arabia and their use against Iraq.

One might ask whether security guarantees—even joined to regional arms control—might induce India and Pakistan to foreswear nuclear weapons or accept significant constraints. The answer is that no credible guarantors are in sight. The Soviet Union can't guarantee even its own integrity, much less anyone else's. Given the history of conflict between India and China and China's support of Pakistan, India certainly can't look to China as a guarantor. The failure of the United States and China to prevent Pakistan's dismemberment in 1971 discredits them as possible guarantors for that nation. And given the historical U.S. tilt toward Pakistan, it is hardly plausible that India would rely on an American security guarantee. Nor would U.S. public opinion—much less that elsewhere in the West—support a guarantee for either Pakistan or India, especially given that there is no vital Western interest in the region—certainly nothing comparable to Middle East oil. Who else—the United Nations? Some hope may lie here, given the end of the Cold War and words of support from both superpowers, but the prospect is remote of the United Nations acting forcefully in the event of a clash of forces as large as India's and Pakistan's.

Still, third parties might be able to do at least something to help restrain nuclear proliferation in South Asia. Just as President Carter brought Anwar Sadat and Menachem Begin together at Camp David, the United States could, without guaranteeing the security of Pakistan, India, or both, try to facilitate a resolution of basic differences. But playing a good-offices role has its costs: half the U.S. foreign aid budget now goes to Israel and Egypt. With American interest in South Asia much less than in the Middle East, the United States is unlikely to pay the same kind of price for playing such a role in that part of the world.

Until basic conflicts between India and Pakistan are dealt with, probably the most that can be done to dampen proliferation pressures is to lessen the chance of one nation pushing its nuclear weapons program further because it misreads what the other is doing. Information exchanges and periodic visits to one another's nuclear facilities, perhaps along the lines of recent Brazilian-Argentinian exchanges, seem to be the best hope.

Proliferation in the Middle East

Nuclear weapons proliferation in the Middle East is at least as complex and intractable as in South Asia. The situation differs in that Israel already has a significant nuclear arsenal or the ability to assemble one quickly.

Israel might conceivably be persuaded to give up its nuclear shield under conditions of true peace with its Arab neighbors. Indeed, both the Arab states and Israel are on record as sup-

Pakistan's Benazir Bhutto (left) and India's Rajiv Gandhi (right) agreed not to attack each other's nuclear facilities. That raised some hope for slowing proliferation in South Asia, but then both leaders were forced from office.

porting the concept of an NWFZ. However, the preconditions that each side has stipulated for the realization of such a zone are patently unacceptable to the other. The Arabs want Israel to foreswear nuclear weapons and open its facilities to international inspection to verify that commitment. And Israel insists that an NWFZ can result only from direct negotiations between the parties—that is, Arab states must grant Israel a form of political recognition. Israel also demands verification procedures that go well beyond the form and content of the present safeguards administered by the International Atomic Energy Agency (IAEA). Thus, an NWFZ is a non-starter, at least for the near term.

More realistic is the possibility of a freeze on nuclear capabilities and perhaps on missiles and chemical weapons. Perhaps Israel would agree to produce no more materials for nuclear weapons if Arab states honor their commitment in the Nuclear Non-Proliferation Treaty (NPT) not to acquire such weapons. The U.S. government has recently prepared a regional arms control plan for the Middle East that incorporates these ideas.

Just as the United States is the only power that has the clout to catalyze a peace process in the Middle East, it is also in the strongest position by far to influence Israeli and Arab decisions on acquiring either unconventional or conventional weapons. Unfortunately, the United States has shown little appetite for pushing Israel on the nuclear issue or for denying high-tech conventional weaponry to any states that support its interests vis-à-vis the Soviet Union. The end of the Cold War and heightened American prestige in the wake of the Gulf War create a window of opportunity to press for peace and arms limitations. Unless this opportunity is pursued, the Middle East will face continuing turmoil and violence and ultimately the proliferation of nuclear states.

Arms Control and Nuclear Proliferation

Two multilateral arms control proposals on the immediate international agenda are relevant to prospects for minimizing the spread of nuclear weapons. These are the initiative to convert the Limited Test-Ban Treaty (LTBT) into a comprehensive one and the possible extension of the NPT.

Whether a comprehensive test ban (CTB) would limit proliferation is arguable. First-generation fission weapons yielding more than 10 kilotons can be developed without nuclear testing, especially if there is little premium on predicting yields precisely. However, nuclear tests are probably necessary to develop fission weapons with high yield-to-weight ratios and extremely predictable yields. The same holds for fission-fusion weapons of all kinds.

These considerations suggest that a CTB could have at least some direct impact on minimizing proliferation. A comprehensive test ban could make acquiring nuclear weapons, especially sophisticated ones, more difficult. This would be particularly true if nations that are not parties to either the NPT or the LTBT were to accede to them. India comes to mind—that country has objected to the NPT for letting nuclear powers keep their weapons, and to the LTBT for permitting underground tests. It is noteworthy that India, Pakistan, Brazil, and Argentina—all threshold states—voted at a U.N. conference in January with the 75-to-2 majority for continuing to try to amend the LTBT to a CTB. But the United States and Britain cast the no votes, and although both countries have committed themselves in the NPT preamble and elsewhere to strive for a comprehensive treaty, the United States has made it clear it would veto attempts to convert the current limited treaty into a comprehensive one.

PHOTOS: REUTERS/BETTMANN

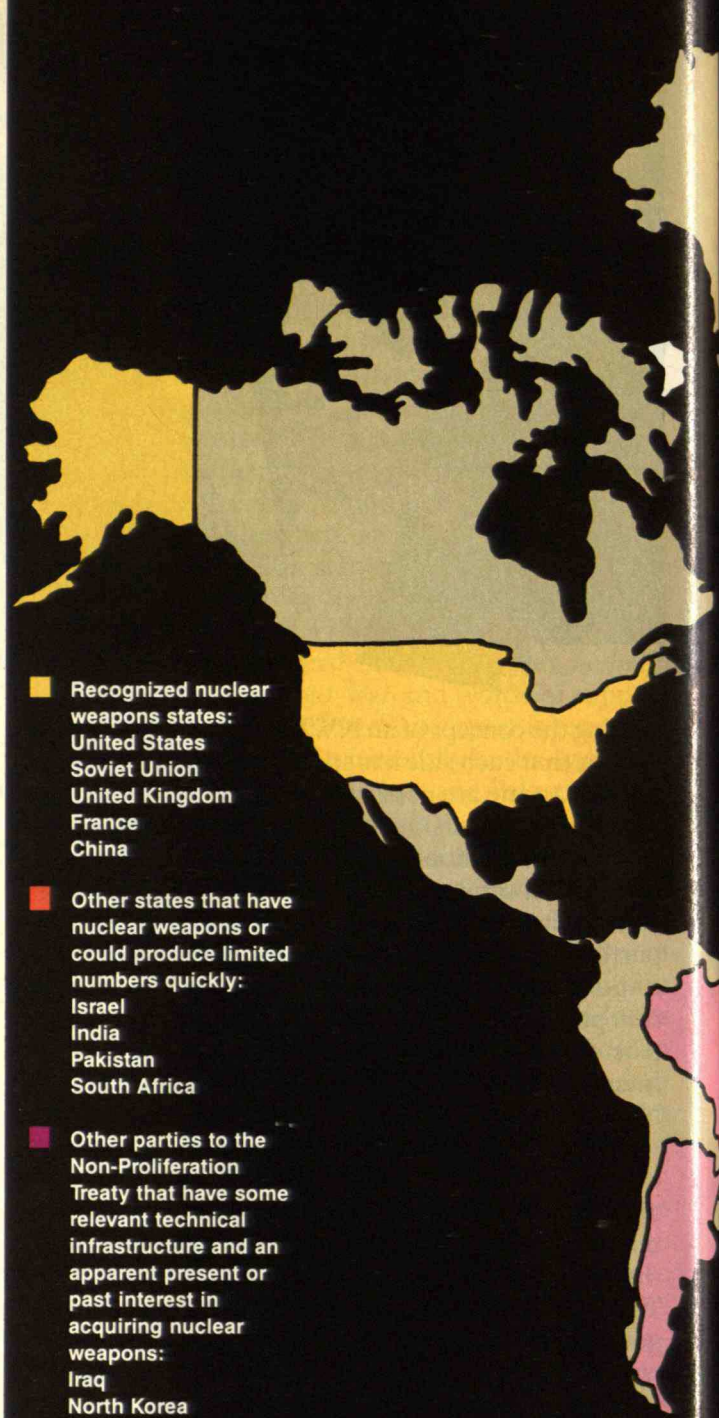
This insistence on testing inevitably accentuates belief among other states that nuclear weapons are desirable. It conveys the impression that those who are most involved with the armaments still attach great importance to them, and that modest advances in weaponry could be important politically or militarily. Thus, passage of a CTB, even one not subscribed to by all threshold states, would lessen the demand for nuclear weapons. Indeed, a comprehensive ban would be more important for this reason than for any effect on capabilities to acquire them.

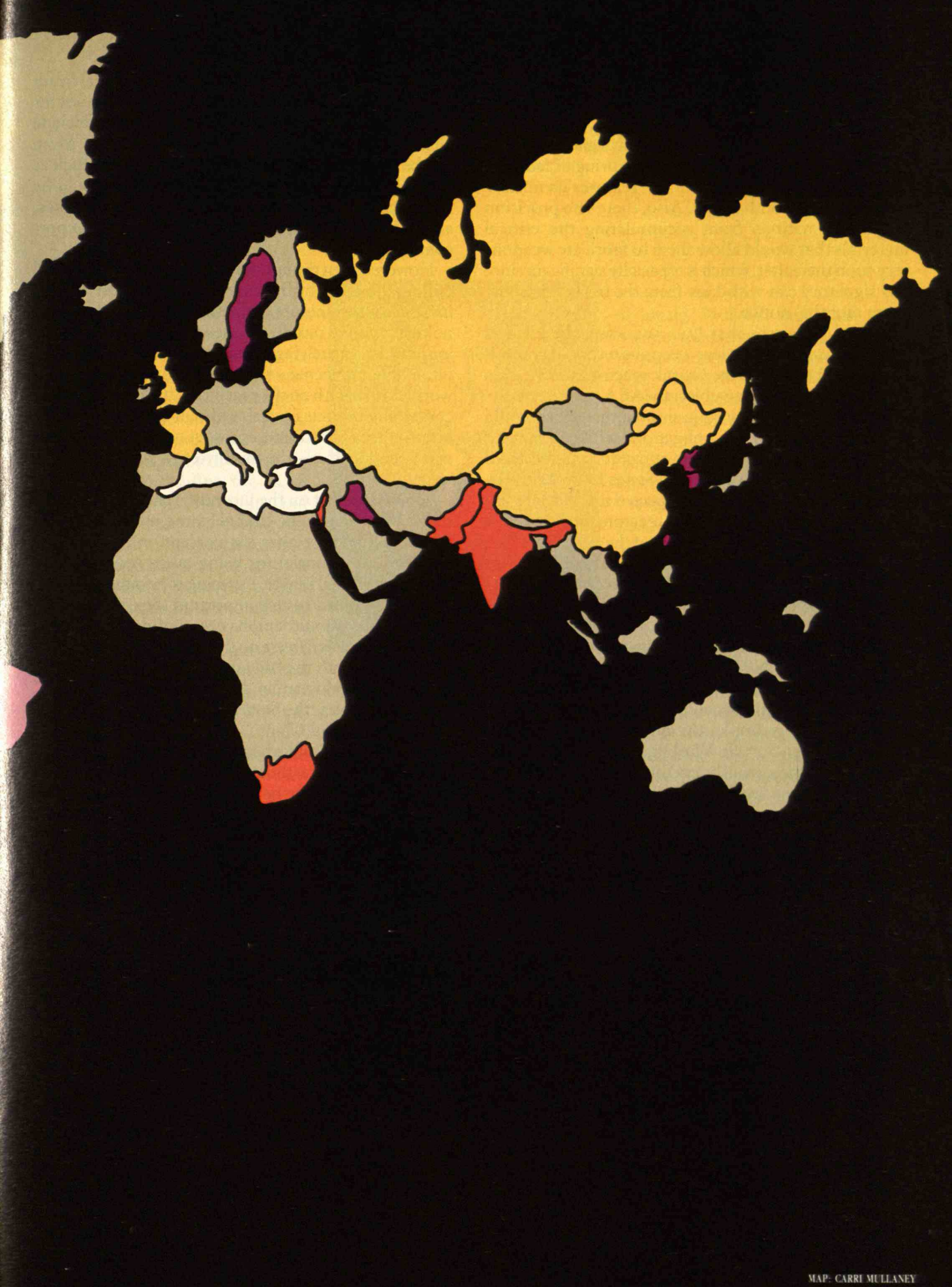
Continued opposition to a CTB seems especially wrong-headed now that the Cold War is over. The principal Western argument against early consummation of a CTB—that the Soviet Union might gain military advantage through clandestine tests—has vanished. Moreover, it seems clear that the reliability of weapons already in the stockpile can be adequately assured by non-nuclear testing. Finally, skepticism is growing about the military utility of nuclear weapons in general and, in particular, of future exotic weapons whose development is one more excuse for tests. In our view, the only plausible rationale for continued testing is to make stockpiled weapons safer. But even in this case, most of what is desirable can be done without any *nuclear* tests. Whatever small advantage there may be in continued nuclear testing would be more than offset if the great powers consummated a CTB, indicating that little is to be gained from the nuclear competition, of which testing has been such a symbol. Certainly, continued resistance to a CTB calls into question the leadership qualifications of the United States and Britain in dealing with proliferation.

The issue of a CTB is directly linked to extending the NPT beyond 1995. At NPT reviews, which have occurred every five years since 1970, non-nuclear states have repeatedly castigated the nuclear states for not expanding the limited test ban to cover underground tests.

But there are more fundamental problems with the NPT. In its genesis and its implementation, it reflects policies of denial—and worse yet, of discriminatory denial: it attempts to prevent non-weapons states from acquiring nuclear weapons but permits the weapons states to retain them, further develop them, and acquire more. Had the weapons states moved with greater vigor toward general disarmament and an end to the nuclear arms race, non-weapons states would surely have objected much less to the treaty. More importantly, the treaty would have reflected a view that little is to be gained from continued development and reliance on nuclear weapons. This did not, of course, happen, and so the NPT must be evaluated principally with regard to its effect on the ability of nations to acquire nuclear weapons.

Even from this perspective, there are serious problems with it. Israel, Pakistan, India, Brazil, and Argentina have not acceded to the treaty because each wants to





MAP: CARRI MULLANEY

retain a nuclear weapons option for security purposes. India, Brazil, and Argentina were influenced by prestige considerations as well. North Korea, another state poised to acquire nuclear weapons, has signed the treaty but will not agree to the IAEA monitoring of facilities required unless the United States removes its nuclear weapons from South Korea. Also, there's no provision to prevent nations from accumulating the critical materials that would allow them to fabricate weapons very soon thereafter, which is especially significant since any signatory can withdraw from the treaty with only three months' notice.

Indeed, concerns that Iraq was using the NPT as cover for acquiring nuclear weapons technology motivated Israel to attack the Osirak reactor in 1981, even though the reactor was subject to IAEA safeguards. Before the Gulf War, Iraq again showed that a state could fulfill the letter of NPT obligations while pursuing a clandestine weapons program at facilities not declared to the IAEA. And so the United States followed the Israeli precedent by bombing suspected nuclear sites, including two small research reactors under IAEA safeguards, during the first hours of the Gulf War. Also, although the treaty provides for challenge inspections at such undeclared facilities, the procedures to implement the inspections are complex and none have occurred.

With these objections, questions have to be raised as to whether the NPT is likely to be extended in 1995, and indeed, whether it should be unless it is strengthened. Some objections could be met without revising the treaty. For example, the nuclear weapons states could take their Article VI obligations to pursue disarmament more seriously, and, in particular, conclude a comprehensive test-ban treaty. However, the major hold-out states are unlikely to subscribe to the NPT unless and until there is progress in mitigating the security concerns that motivate them to acquire nuclear armaments.

Dealing with Insecurity

We are left to ask: Are the nations of the world willing to make the tough trade-offs needed to reduce the potential for nuclear proliferation?

U.S. non-proliferation policy has traditionally been based on discussion and denial, in particular on support for the NPT regime, IAEA safeguards, and regulating the flow of nuclear technology by a system of domestic and international export controls. To this has now been added the selective use of military action to destroy the emerging nuclear capability of states who threaten U.S. interests.

Much can be done to shore up the traditional pillars of the non-proliferation regime. The NPT treaty would be enhanced if it incorporated stiff sanctions for violations and if it extended IAEA safeguards to include all nuclear activities, not just those states declare. More can be done to minimize the flow of sensitive nuclear technology and weapons-usable materials to would-be proliferators if supplier states, including emerging ones, act in concert to develop and enforce strong export controls.

However, even though such changes constitute a tall diplomatic order by themselves, they are nevertheless insufficient to minimize proliferation, especially as technological denial rapidly reaches the point of diminishing returns. And relying on military action is dangerous, ultimately ineffective, and potentially addictive. In a world dotted with nuclear facilities, including reactors containing billions of curies of radioactivity, military action courts catastrophe and does not reduce—indeed may even increase—the incentives to acquire nuclear weapons.

To make a dent on the incentives end, the weapons states, particularly the United States, must lead by example. They must alter the perception that nuclear weapons are essential for being taken seriously as a world or regional power. Agreeing to resume negotiating a CTB would be one important step. Also, diplomatic efforts should emphasize confidence-building measures, such as a freeze on the production of weapons materials in both the "de facto" weapons states, such as Israel and Pakistan, and within the "nuclear club," the United States, the Soviet Union, the United Kingdom, France, and China.

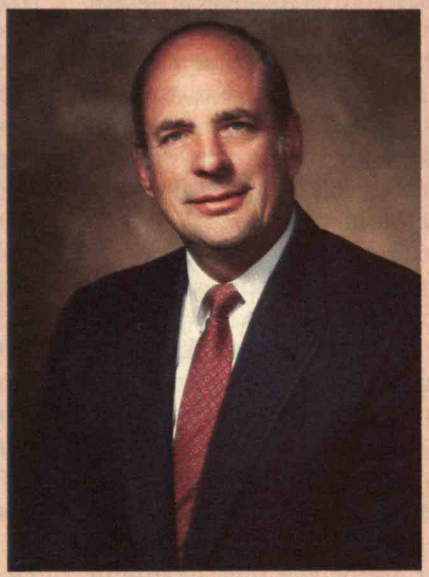
But in the long run, there can be little hope of stemming proliferation without major changes in world order. The price will often be the economic or political costs of dealing with long-standing political difference, and this price may be very high.

In particular, serious arms control negotiations cannot proceed without concomitant progress toward resolving the Arab-Israeli conflict. In that region, we now confront as immediate and clear-cut a case for U.S. leadership as can be imagined. Unless the administration is prepared to mobilize international and domestic support for a peaceful, though painful, resolution of basic regional problems, even as it did in taking on Saddam Hussein, there can be little hope of stemming the spread—and ultimately the likely use—of nuclear weapons in that area, probably to be followed by such spread and use elsewhere.

We are persuaded that proliferation is dangerous and cannot be wholly eliminated in a world where possession of nuclear weapons is legitimate for some states but not others. Still, much can and should be done now to minimize the threat of proliferation. Though the political and economic costs may be great, so too are the risks of business as usual. ■

Rethinking Space

AN INTERVIEW WITH NORMAN R. AUGUSTINE



Leader of an influential panel on the future of the space program, Martin Marietta's top executive finds hope amidst battered illusions.

THE space program has ridden a roller coaster of popularity. Public support has crested with dramatic achievements as moon landings and gorgeous photos of Saturn's rings. Recently, however, there have been more lows than highs. Even before the Challenger disaster, the space shuttle was falling short of its goal to provide routine, low-cost access to earth orbit. The space station, once touted as the next logical step in our conquest of space, has bogged down in budget battles and unclear purpose.

When fundamental questions arise about any matter of national importance, Washington has a standard response: appoint a blue-ribbon commission to study the issue. Thus it seemed business as usual last year when NASA and the National Space Council formed the Advisory Committee on the Future of the U.S. Space Program. Heading the panel was Norman R. Augustine, chief executive of Martin Marietta.

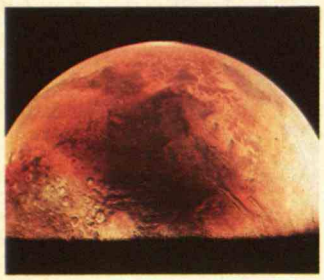
The Augustine committee produced its report in December to virtually universal praise. The committee re-evaluated the shuttle program and called for re-thinking and downsizing the space station. It also laid out in a general way what the United States ought to be doing in space. The panel recommended both a "mission *to* planet earth"—a series of earth-observing satellites aimed at furthering understanding of our planet's climatic changes—and a "mission *from* planet earth"—essentially a Mars program. The panel also recommended that the space program focus mainly on science as opposed to industrial activity.

Putting Augustine in charge, said one analyst, was a way of guaranteeing that the panel would be taken seriously. Probably no other aerospace executive commands such respect from diverse quarters. John Pike, director of the Federation of American Scientists' space policy project and a frequent critic of the defense industry, calls Augustine the "philosopher king" of the aerospace business.

His 1982 book, *Augustine's Laws,* pokes fun at the frustrating and sometimes bizarre habits that seem to govern Washington decision making. Augustine's Law Number I: "The thickness of the proposal required to win a multimillion dollar contract is about one millimeter per million. If all proposals conforming to this standard were piled one on top of the other at the bottom of the Grand Canyon, it would probably be a good idea." And noting the increasing complexity, and cost, of military aircraft led him to extrapolate that "in the year 2054, the entire defense budget will purchase just one tactical aircraft. This aircraft will have to be shared by the Air Force and Navy 3½ days each per week, except for leap year, when it will be made available to the Marines for the extra day." (Law Number IX.)

Such barbs carry all the more weight because Augustine is an insider. Before joining Martin Marietta in 1977, he was Under Secretary of the Army. He is a member of the Defense Science Board, an influential group that in 1988 recommended a more assertive military role in setting economic policy as a way to prevent further erosion of U.S. leadership in key technologies such as semiconductors.

Technology Review senior editor Herb Brody talked to Augustine about his vision for why we should be in space and what stands in the way of further progress.



"It's very difficult to build an intellectually honest argument that says we have to get to Mars by a certain year. And if you don't know what something will cost, setting a date is a non sequitur."

TR: Advocates and critics of most any program can find in your report words to back their positions. Why so much ambiguity?

AUGUSTINE: The report says that the highest priority goal in space should be science; that you have a mission to planet earth and a mission from planet earth, but that you don't begin either until you have the technology base rebuilt; that you will build a new launch vehicle; that you will curtail the use of the space shuttle; that you will redesign the space station; that you will reorganize NASA; and so forth. If that is vague, then so be it.

TR: But the committee sometimes seems to fudge its recommendations. The purpose of the space station seems particularly fuzzy. Could you explain what you have in mind there?

AUGUSTINE: A lot of people had trouble with that. The ambiguity is not deliberate, but there is a subtlety. Let me go through the logic. First, we believe that we should have a humans-in-space program. If you believe that, then the clear, long-term goal is to put humans on Mars. Other planets are too hard to get to and too uncomfortable when you get there.

Now if you want to go to Mars, there is only one known show-stopper, and that is the long-duration effects of space exposure on the human system. And the only place to gather that data on long-term human exposure is in space. So you need some kind of laboratory where you can get long-term data on humans in space. And that is the raison d'etre of the space station. It's the *only* reason we can justify it. We can't justify it based on its use as a transportation node, as a scientific outpost, for doing materials processing, or all those things combined.

TR: So the space station should be primarily a life sciences lab?

AUGUSTINE: Not necessarily. Once you've *got* a space station, it's easy to justify its use, from a marginal cost standpoint, for microgravity research. In fact, once the station is built, it may make more sense to give greater time urgency to microgravity work.

TR: That seems like a contradiction.

AUGUSTINE: It's very difficult to build an intellectually honest argument that says we have to get to Mars by a certain year. We're not racing the Russians like we were to the moon, or at least we thought we were. On the other hand, the microgravity program is intended to help America's industrial competitiveness, in which there is a great deal of urgency. So even though it's a secondary mission in terms of justification, we think it may have the highest priority in terms of time urgency.

TR: What happens if the space station is scaled back, as has been proposed—can you still do good science?

AUGUSTINE: Certainly we'll gain useful information. But obviously there's a trade to be made between the scope of the space station and the scientific data it will yield.

Going to Mars

TR: In recommending a mission to Mars, you acknowledge that the benefits would be largely intangible, such as satisfying the human need to explore the unknown. Is that justification enough for such an expensive undertaking?

AUGUSTINE: Think of all the things we do here on the earth in the way of exploring the poles, mountaintops, and under the sea. There are often no real measurable benefits, but I think few people would argue that these things are not worthwhile. I think that space exploration—particularly manned exploration—falls into that category. There could be enormous, tangible payoff in space exploration and monitoring—ranging from finding valuable mineral sources to discovering intelligent life. But it's very uncertain that we will get such payoffs. So we ought to be satisfied that the sole benefit of space exploration might turn out to be intangible. And that seems to us to be worthwhile still.

There's an analogy between exploration and basic research: You don't know what you're going to find until you find it. It's very hard to build a justification for any specific piece of basic research, but we all

know that research in general has an enormous payoff.

TR: Space travel is far more expensive than earthbound exploration.

AUGUSTINE: I suspect that if you added up what people will spend on professional sports between now and the time we get to Mars, the Mars program would look fairly modest. Do I believe that we should shut down our social programs, our safety nets for unfortunate people here on earth so we can go to Mars? No. But I do believe that the country has sufficient wealth that we can do both. One of the reasons why the committee didn't argue that we should try to go to Mars by a particular date was that we recognize that there are other priorities.

TR: Maybe the committee was just acknowledging what had been the true motivation for space travel all along, depite all the talk about material benefits and commercial spinoffs.

AUGUSTINE: During the moon program, there was never much question in my mind that the only significant benefit would be intangible. I never had any great hope for any near-term, tangible payoff for having been to the moon.

But "intangible" is certainly not synonymous with unimportant or insignificant. The moon landings came right on the heels of the Vietnam War. The country was in the doldrums. We had just finished burning down parts of some of our cities. America was given a high from the Apollo successes that I thought it badly needed at that time.

I remember during those Vietnam War years when we were trying to strengthen our alliances with other countries and America was not all that popular around the world. I can remember when by far the most popular visitors to other countries and our best representatives were not our congressmen, not our CEOs, not our state department, but—

TR: The astronauts.

AUGUSTINE: Exactly.

TR: The committee suggests a "go as you pay" Mars program, with the size of the program tied to the available funding. Might this be a a recipe for never getting there? Without a deadline, wouldn't the program keep getting pushed off the agenda for more urgent projects?

AUGUSTINE: One of the reasons we got to the moon when we did was that President Kennedy set a date certain that was near and measurable. A commitment was made. One difficulty in going to Mars is that we really don't know what it will cost. And if you don't know what something will cost, and you're resource-limited more than you're technology-limited, then to set a date certain is a non sequitur. But that makes the mission no less important.

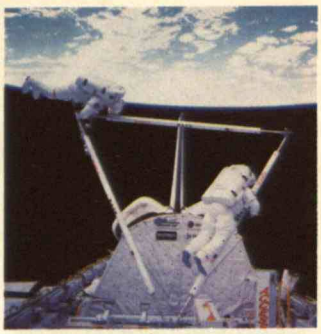
TR: Won't the lack of a deadline also make it more difficult to make technological decisions? If you say we're going to do this in 50 years, then you might choose to pursue different technologies than if you're going to try to do it in 20 years.

AUGUSTINE: That's absolutely right. But most of us have some idea of the general window we have in mind. And usually the make-or-break technologies don't have time constants of two or three or five years. My hope would be that sometime around the year 2020 we'll get to Mars, give or take a few years.

The Human Role

TR: The report seems ambiguous on the human role in space. Could you clarify what you think that is?

AUGUSTINE: There is a great deal that can be done unmanned. But we asked ourselves, should America be content with a totally unmanned program, and we came out with a resounding "No." For one thing, one sacrifices the ability to do things that only humans can do in space. The rescue, repair, and redeployment of the Solar Max—a spacecraft carrying sophisticated instruments to study the sun's activity—is an example where we encountered a surprise while in orbit. Without any humans there, I think there's little chance we could



"A space program with no in situ human involvement would not provide as much of an inspiration. If there were no manned program, the unmanned program would start to dry up as well."

"I never had any great hope for near-term, tangible payoffs for having been to the moon. But America got a 'high' from the Apollo successes that I thought it badly needed."

have saved the Solar Max.

Further, it would seem to us that a space program with no *in situ* human involvement would not provide as much of an inspiration. That's important in and of itself, and it also means that the space program would probably not receive public support of any great magnitude. If there were no manned program, it wouldn't be long before the unmanned program would start to dry up as well. The public would just lose interest.

TR: So public excitement is key to the success of the space program?

AUGUSTINE: It's very important. Congress doesn't approve funds for things, by and large, that the public doesn't support. The good news for people who believe in the space program is that the public really is excited about space—to a degree beyond what I would have imagined. Our committee received all kinds of letters from people and listened to many witnesses and, although many of them criticized certain aspects of the space program we're now pursuing, they were, almost to an individual, supportive of a strong, healthy space program. Here in Washington, more people visit the Air and Space museum every year than go to the Capitol, the Washington Monument, the Lincoln Memorial, the Jefferson Memorial, and the Vietnam Memorial combined.

TR: Maybe that's because the museum puts on a better show.

AUGUSTINE: But if people were bored, or turned off by space, they wouldn't go to the space museum. But I would agree that the show there is better in general than the one at the Capitol.

Finding Funds and Talent

TR: Is it realistic to assume, as you did, that the NASA budget will grow by 10 percent a year?

AUGUSTINE: Yes. For about 15 years, NASA's budget has in fact been growing moderately in real terms, in spite of difficult budget pressures, approximately doubling in size. Secondly, last year the administration requested nearly 20 percent real growth and Congress approved eight and a half percent real growth. Finally, in the past, at the peak of the Apollo program, we spent eight tenths of a percent of the gross national product on civil space. Today, it's near a quarter of a percent.

TR: Of course, the country wasn't facing the same budget crunch then.

AUGUSTINE: That's true, but even so it doesn't seem that space spending ought to drop by a factor of three relative to GNP. Furthermore, the NASA budget is only around $15 billion. It's a tiny fraction of what we pay for interest on the national debt. So the difference between the space program growing at 5 percent and at 15 percent is not that large on the scale of federal spending. It becomes more a question of do you have a good space program that you really believe in. If you do, then the money is not that big an issue.

TR: Is there a drain of talent out of NASA, or a lack of talent going in?

AUGUSTINE: Yes, both of those things. Salaries at NASA are substantially below those of private industry. So that's one thing we should fix. Pay isn't the whole story—but it's part of the problem.

TR: How else can we keep the space program filled with top people?

AUGUSTINE: Throughout its history, NASA's talent base has been bolstered by people who have come to the agency from academia and industry for short periods to work on various projects. These people bring a different perspective to the agency—they are more apt to take new approaches. It's a very valuable leavening, and we need to keep doing that.

Science and Industry

TR: The committee recommends giving highest priority to space science. Why is space science so urgent?

AUGUSTINE: First of all, when we said space science, we really mean science as-

sociated with the space program, as opposed solely to, say, astrophysics. We include materials science, electronics science, and so on. The reason we gave that such a high priority is that we see science as the source of new technical knowledge, which in turn is the basis for anything new that we can do, whether it be building products that help competitiveness, developing a better understanding of the universe, or improving our educational system. We see science as the fundamental building block for all these other things.

TR: The committee didn't say much about industry's role in space. Why not?

AUGUSTINE: We on the committee all believe that any real long-term payoff in space is going to have to involve industrialization. But we are very guarded about how soon that's going to be possible. With the exception of the communication satellite industry, which is a flying success already, we are cautious about how quickly you are going to see space industry emerge.

TR: With factories in orbit?

AUGUSTINE: Exactly. That will happen. But most of us are a little guarded about how soon that will be. It's tough in America's economic system to be financially viable in fields that require major capital hurdles to begin with and then take long terms to pay off.

The Shuttle, The Station, and NASP

TR: The space station and the space shuttle have been the linchpins of the space program for a long time. Now you and other people are saying that they're flawed. How did we get into this situation where the fundamental parts of the program are so in need of fixing?

AUGUSTINE: It's important to say, first of all, that we are where we are. We have a space shuttle program, and we're heavily dependent on it, and we will be for another decade at least. We have a space station started, and it has certain features, and we have a certain investment in it in terms of talent, money, and momentum. And the latter is not insignificant.

TR: Do you mean that we ought to keep a program, no matter how misguided, just because it has "momentum"?

AUGUSTINE: If it were 180 degrees out of direction, I would argue that one should stop altogether. If we're 12 degrees off course, I am pragmatic enough to be willing to steer the 12 degrees back.

Now, your question was, why do we have this problem. I think that we're in a new era from where we were when we began the program. At the time space station began, we thought we were going to have a good deal more money than we have, and we thought there were justifications that were much broader than our committee was able to agree with: we were going to use the space station as a basic science laboratory, and for materials manufacturing, then we would use it as a transportation node, and so forth. Our group finds it difficult to now agree with all that.

The shuttle, candidly, has not met its principle design objective, which was to reduce the cost of operating in space. When I first heard of the shuttle, we were discussing something like 60 missions a year. You're in a very different price league at 60 missions year than you are at 10 missions.

TR: One of the big questions facing the space program is choosing a new launch vehicle to take the place of the Shuttle for carrying payloads into orbit. Why didn't you make a more explicit recommendation on the type of vehicle that was needed?

AUGUSTINE: We spent a good deal of time on the committee trying to design that launch vehicle. It was the most enjoyable part of the study, and it never got a page in the report. Nearly all of us are engineers, and we thought we might be good at it. But it soon became clear to us that in 120 days we were not going to design America's next launch vehicle, no matter how much we enjoyed trying. So instead we decided to just provide the specifications for that vehicle: what should it do? Why should you have it? Then we would give it to the experts, who have the talent and the time to design the launch vehicle. So we made a very cons-

"The shuttle, candidly, has not met its principle design objective, which was to reduce the cost of operating in space."

"We could not find the near-term justification for using an aerospace plane to transport pay loads to orbit. If push came to shove in the budget, we would not put the plane at the top of the priority list."

cious decision to get out of the vehicle design business. And we did that with a great deal of professional disappointment.

TR: You seem to waffle on the issue of whether we should build the National Aerospace Plane, or NASP, for access to orbit.

AUGUSTINE: Perhaps we weren't as clear as we should have been on that. The committee believes that the building of prototypes with new, high-risk, quantum-jump gains in technology is an important thing for NASA to be doing. The committee therefore would support the NASP program.

TR: Should NASP be given priority as a launch vehicle?

AUGUSTINE: We could not find the near-term justification for using a NASP to transport payloads to orbit. That sounds like it's a long way away. Some of the technology might have application to commercial transport, which we think is important. But only some of the NASP technology would have that kind of potential, because NASP is really aimed a step beyond what you might expect from the next generation commercial aircraft. So we concluded that NASP, given a very constrained budget, would not compete well with some of the other things that NASA has to do, such as redesigning a space station and completing the mission to planet earth. We support NASP, we hope NASP could be completed, but if push comes to shove in the budget, we would not put NASP at the top of the priority list.

TR: You say that NASA's technology base has been "starved" for funding for some time. What particular areas of technology have been particularly hurt by lack of funding? Where does the most remedial work need to go?

AUGUSTINE: There is, unfortunately, a huge body of examples. One area is the life sciences. In addition to studying the biological effects of calcification, solar flares, muscular atrophy, and so on, we also need to do things like design gloves so that astronauts can use their hands effectively in space. And we need spacesuits that astronauts can be comfortable in for long periods of extravehicular activity. In propulsion technology, we need to do a lot of work on main engines. Then there are more exotic technologies, like aerobraking.

TR: What's that?

AUGUSTINE: That's the concept of using a planet's atmosphere to slow a space vehicle for entry into orbit, orbital transfer, or re-entry. Aerobraking has been identified as a critical technology for future space exploration missions and is scheduled to be tested on a shuttle mission in the mid-1990s. Keys to success include vehicle design, computer software, and advanced heat-protection materials.

Playing it Safe

TR: The report says that the nation has become risk-averse. Is that hurting the space program?

AUGUSTINE: I think today the emphasis on many things in America is becoming more and more one of don't let anything go wrong, rather than be sure something goes right. I'm not sure I would argue that the space program ought to become more risk-taking. But the public will need to be more willing to accept the consequences of risk, and accept the reality and the necessity of risk. We need a willingness to step out from the crowd, to do something that may fail if the payoff of success makes it all worthwhile. The media is prepared to ridicule someone who fails. The auditors are prepared to tell why they failed and make sure they'll never fail again. And there's one way to make sure you have no failures—it's a guaranteed way. I just hate to see America move in that direction.

There's very little that you accomplish that's worth accomplishing that doesn't entail the risk of failure. And if you're not willing to accept the risk of failure, you certainly shouldn't be in space. You probably shouldn't be in business in general, nor

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in a lot of other things. The public servant who supports a program to Mars, or a space telescope, or any other challenging program, is not likely to do it in the future if the penalties for failure are greater than the rewards for success.

TR: What particular decisions can you point to as examples of that risk aversion?

AUGUSTINE: They include, having tested something to the 99th percentile of confidence, and then saying, OK, we'll go test it 6 more times. It costs money to do that, it takes time to do that, and the benefit gained often doesn't begin to match the cost. The approval of new medicines in some cases comes to mind. There are also cases in the defense arena where things got tested, and checked, and verified, to the point that they will never get out onto the battlefield to help anybody who needs them—even though nothing fundamental has gone wrong with them.

TR: What does the end of the Cold War mean for the space program? Will there be more civilian opportunities because of lessening military need?

AUGUSTINE: You could read both positive and negative aspects of it. The Cold War is what provided the time urgency to get to the moon as fast as we did. Now that we're not in a race, there are a lot of opportunities for cooperation. We may be able to share technology and costs with the Soviets, the Japanese, and many others. With respect to the military, much of what the military does in space you want to do well during peacetime as well.

TR: Like satellite reconaissance for treaty verification?

AUGUSTINE: Right. In addition to reconnaissance, there will be a continuing military presence in space, including early-warning systems, navigation, communication, and meteorological systems.

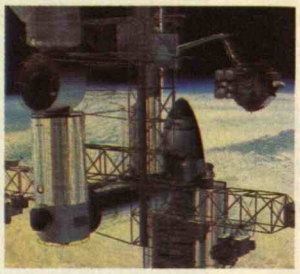
TR: How can you prevent your committee's report from gathering dust on a shelf?

AUGUSTINE: One thing that helps is that the report has received almost universal support. No one was more surprised by that than the committee itself, I assure you. When I began, I thought there was no possible outcome of our work that could produce other than a huge donnybrook. It appears that maybe we have helped build a bit of a consensus. That's an important first step—if you can't agree on where you're going, you're not likely to get there, particularly in a 30-year undertaking or whatevever it might be.

TR: What happens now?

AUGUSTINE: The next step is in the government's hands. Our committee is basically done—and our part was the easy part. The hard part will be to make any of it happen. But as much as any other study I've ever been involved in, there seems to be a mechanism and a momentum building to really do these things. NASA has put together a very organized approach to following up on the findings. NASA Administrator [Richard H.] Truly has committed to going through every finding carefully and deciding which ones are worth pursuing. The various NASA centers are doing the same thing. The National Space Council has generally endorsed the report's findings. The president's budget this year reflects the report's recommendations, including the heavy lift launch vehicle, restructuring of the space station, and refraining from building a new orbiter.

The success of our effort will depend not only on NASA but very heavily on the Congress. If Congress finds it impossible to provide the budget stability needed to let NASA manage its affairs, and impossible to provide the wherewithal to hire and keep the kind of talented individuals that will be needed to carry out the program with the aggressiveness we have suggested, then the program will fail. My belief is that in fact America can and should look forward to a very successful future in space. ■



"If you want to go to Mars, there is only one known show-stopper: the effects of space exposure on the human system. A space station could provide long-term data on humans in space—that is the only *reason we can justify building it."*

MIT

AUGUST/SEPTEMBER 1991

MIT
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COVER

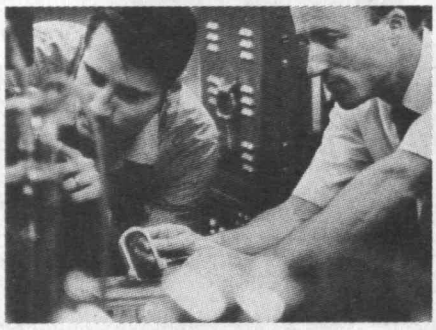
It wasn't original: Corinne Wayshak, for one, graduated in 1989 with a video camera on her mortarboard. But we do wish we could tell you the name of this member of the Class of '91. We applaud his and others' efforts to individualize a uniform. (Photo by Paula Lerner)

LETTERS

HERE'S TO TEACHERS WHO TEACH

As an engineer and mother of two young children, I was very pleased to read the report "Jump-Starting Science Education" in the February/March 1991 *Technology Review*. I would like to see more coverage of the efforts underway at MIT to address this problem and how concerned parents and alumni can participate, with the hope that my son's third grade teacher will know more science than he.

M. L. McCARTHY, SM '81
Hampton, Va.



JIM MELCHER'S HEIRS

Bittersweet emotion and no little coincidence closely followed arrival of the April 1991 issue of *Technology Review* in my mailbox. This issue contained an abridged version of the article "America's Perestroika," written by Professor James R. Melcher, PhD '62, in the last months before his untimely death. On the title page of the article appeared a 22- or 23-year-old photograph of Jim in the old Continuum Electromechanics Laboratory (Building 31). And there with him in that photo was I, looking busy and intent. Jim was holding a dielectric syphon—the thing that looks like a horseshoe—a simple electric-field-controlled liquid flow structure that I had investigated in the early stages of my doctoral research.

The coincidence was that Mike Perry, '69, who assisted me in studying the dielectric siphon, arrived from Schenectady, N.Y., with his family for a short visit on the same day that the *Tech Review* issue was delivered! A close examination of that photograph revealed two treasures: (i) my once luxuriant hair; and (ii) a shared intellectual intensity. Now I would certainly like to have the hair back, but at least some of the old intensity remains. Any of us who studied or worked with him will mourn Jim's passing, but we will smile, knowing how he lives on within us.

THOMAS B. JONES, JR., '66
Professor of Electrical Engineering
University of Rochester

IF THIS ISN'T CARDINAL, WHAT IS?

On the opening page of the alumni/ae section of the May/June *Review* there is speculation about the origin of the Institute's colors. This brings to mind a different question about them that arose some time in the period (1924–1928) when I was at Tech doing graduate work. The issue then was just what shade of red was meant by "cardinal." I think there was some intention of fusing them in vitreous tiles for permanent reference.

The matter was put in the hands of Professor Samuel P. Mulliken, Class of 1887, one of whose specialties was the chemistry of dyes. I was his lab assistant at the time, and I remember well his showing me the final three contenders. One represented the consensus of the colorist profession, which I think he favored. The second was a diploma ribbon, which had to be considered because it had been submitted by the rich widow of an alumnus. The third was a fragment of fabric obtained by a priest friend of Professor Mulliken from the robe of the then cardinal of Boston. Professor Mulliken's comment was: "If this isn't cardinal, what is?"

I don't remember how, or even if, the matter was resolved, but I have always enjoyed the memory of the incident.

JULIAN W. HILL, PhD '28
Vineyard Haven, Mass.

Professor Mulliken's Committee to Determine Official MIT Colors sent a duplicate sample of the original colors chosen in 1876 to the U.S. Bureau of Standards to be measured on their spectrophotometer. The results determined, "as a function of wavelength, and for the condition of diffuse illumination, the ratio between the brightness of the sample and the brightness of a surface of magnesium oxide" (each viewed in a direction normal to its surface). As a thesis problem, Ernest M. Fell, '30, worked out some dyeing procedures for the colors established.—Ed.

PHOTO: MIT MUSEUM

The Best Invention of 1991

People think high-tech means futuristic things like complicated computers and hardware. But we think the future is simplicity," says Krisztina Holly, '89, describing Dial-a-Fish, the product she and teammates Michael Cassidy, '85, and John Barrus, '87, developed. Holly and Barrus are currently graduate students at MIT.

Their invention, a simple home grocery shopping and delivery system, received the top prize of $10,000 in the second annual MIT Entrepreneurial Competition, organized by the Sloan New Venture Association and the MIT Entrepreneurs Club. Two other teams, Sliton Technologies and E&M Electronics, each received $1,000 as runners-up.

Dial-a-Fish is designed for people who hate to shop or don't have time. All that's needed is a supermarket catalogue and a portable, palm-sized bar-code wand connected to a telephone. The wand is passed over a bar code printed next to each catalogue item. The store's computer confirms each product name and price in a friendly voice. Customers can then specify home delivery or pick up the packaged groceries themselves and the bill can be charged to their credit card.

Holly, Cassidy, and Barrus have formed Zebratech Systems to market Dial-a-Fish. A major supermarket has already agreed to try the system. If all goes well, it could be available to shoppers as early as this summer.

Cassidy says market research convinced the team that Dial-a-Fish was an idea whose time had come. "We interviewed 200 people in a supermarket, and asked if they would be interested in a service like this that cost $5 per order. Forty percent said they would be. Ten percent wanted to sign up right away," he said. Many said they would be willing to pay more than $5 per order. And people with small kids loved.

The idea initially emerged from a class project in the New Products Program, a joint graduate endeavor under the auspices of the Mechanical Engineering and EECS Departments and Sloan, in the spring of 1990. Robert Rines, '42, president of the Franklin Pierce Law Center in New Hampshire and a lecturer in EECS, was intrigued with the product. He arranged funding from Franklin Pierce that enabled the team to build a prototype and helped them apply for patent protection.

Holly, Cassidy, and Barrus continued working on Dial-a-Fish and were well along the entrepreneurial trail when the competition was announced. "People keep saying, 'Now that you've won, are you going to make a business?' And our response is that we were always planning to do that! We entered the contest to bring attention to our work and meet people who might be able to help us," explained Cassidy.

What makes this entrepreneurial venture work? According to Barrus, it's a combination of hard work and compatibility. "Each of us has given 150 percent. It's remarkable, considering we've got lots of other things going on in our lives. It's not often you get a group of people who can work this well together," he says.

ILLUSTRATION: JON McINTOSH

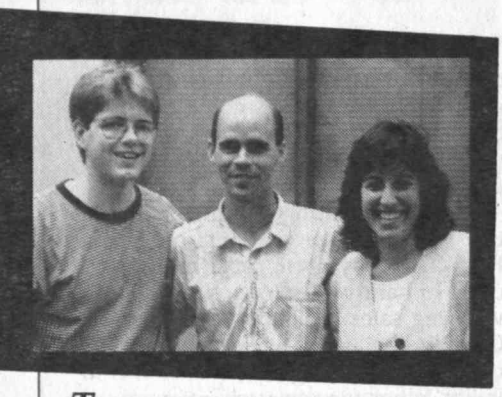
Instead of getting summer jobs, the trio will continue working on Dial-a-Fish. They say their prize money will come in handy—for food, rent, and developing sales brochures. According to Cassidy, the award will also help in less tangible ways. "It gives us a lot of credibility. When we approach potential customers we can say, 'We won the MIT best invention of the year, and we're offering the product to you,' which sounds a lot better than saying, 'We've got this idea, are you interested?' "

Runners-up Mike Moldoveanu, '91, and Janice Dearlove, '91, designed a wireless short-range communications system. The system will operate in the new ISM (Industrial-Security-Medical) band, and spreads the signal by hopping among several pre-assigned frequencies. Their company, Soliton Technologies, is working with a Canadian manufacturer of mineral and coal transportation equipment that is interested in using the product for communications among wagons.

Also honored as runners-up were graduate students Chris Eugster and Martin Muendel, who founded E&M Electronics. The team has developed a cattle identification and recording system in which each animal would wear an ear tag listing its weight, grain consumption, and other vital statistics. This information could be downloaded onto a personal computer so that ranchers could monitor important feedlot statistics.

According to Chair of the Judging Committee Lita Nelson, '64, of the MIT Technology Licensing Office, Dial-a-Fish was awarded top prize for a number of reasons. "First, they had identified and tested an interesting market. Second, they had come very far by bootstrapping, and had come a long way through diligence and determination. Third, they had a working prototype, were able to demonstrate the concept, and had a patent filed," she said.

The 10K Entrepreneurial Competition is open to all MIT undergraduate and graduate students. This year there were 41 entries, of which 10 were selected as



This year's 10K Entrepreneurial Contest winners (from left): John Barrus, Michael Cassidy, and Krisztina Holly.

finalists. Finalists were required to write 30-page business plans to make it to the final round. Prizes were awarded during a ceremony in May.

Keynote speaker for the awards ceremony was Gordon Bell, ScD '53, who headed Digital Equipment Corp.'s engineering department for 23 years and founded Encor Computer and Ardent Computer. Bell has written a textbook on start-ups called *High-Tech Ventures: A Guide to Entrepreneurial Success.*

Contest sponsors included several prominent venture-capital, legal, accounting, and technology firms, among them: 31 Ventures; Burr Egan & Deleage; Copley Venture Associates; Sullivan & Worcester; Hamilton, Brooks, Smith & Reynolds; Price Waterhouse; Nicolazzo & Associates; Thermo Electron Corp.; and MIT's Sloan School of Management, School of Engineering, Technology Licensing Office, and Enterprise Forum.—*Judith Norkin* □

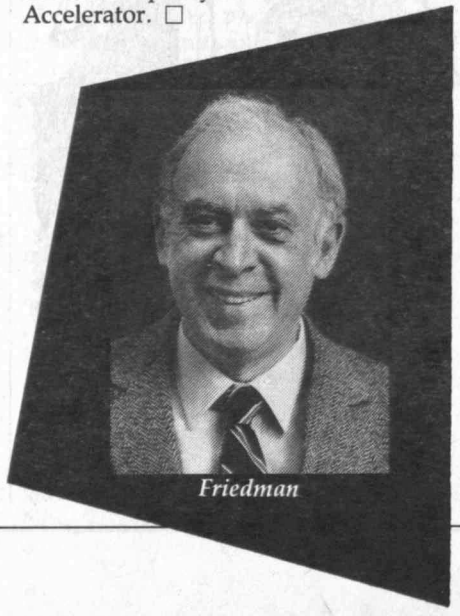
The author is a freelance writer based in Acton, Mass.

Friedman Named Institute Professor

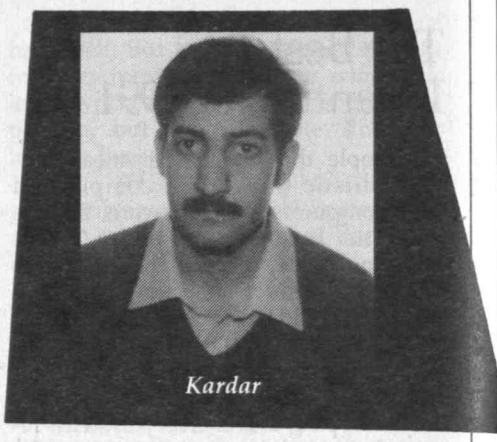
Nobel Laureate Jerome I. Friedman has been named an Institute Professor, the highest accolade bestowed on a colleague by the MIT faculty in conjunction with the administration. Friedman, the William Coolidge Professor of Physics, shared the 1990 Nobel Prize for Physics with MIT Professor Henry Kendall, PhD '55, and Richard E. Taylor of the Stanford Linear Accelerator for their work confirming the existence of quarks. Earlier in his career, Friedman was a co-discoverer of the violation of parity conservation in the decay of the mu meson. This result, along with others, forced a new view of the symmetries satisfied by the laws of physics.

An ad-hoc faculty committee, which recommended Friedman, said that his accomplishments on many levels qualify him for the distinction of Institute Professor. In addition to his international reputation as a superb physicist, Friedman has made significant contributions to undergraduate education and the education of minority students at MIT. It was largely at his initiative, his colleagues say, that the Department of Physics placed undergraduate education at the forefront of its mission. As department head from 1983–88, he also strengthened the department by recruiting junior faculty and led the effort to pay their full academic-year salaries from department funds—an action widely hailed as a major improvement in the "quality of life" for junior faculty. He is viewed as the key figure responsible for the fact that MIT educates 15 percent of the underrepresented U.S. minorities majoring in physics.

Friedman has been a long-time member of the Creative Arts Council at MIT. From 1980–83, he was director of the Laboratory for Nuclear Science. He is chair of the Scientific Policy Committee of the Superconducting Supercollider being built in Texas, and has served in the same capacity at the Stanford Linear Accelerator. □



Friedman



Kardar

Edgerton Award to Kardar

Mehran Kardar, PhD '83, a 33-year-old condensed-matter theorist and associate professor of physics, has been awarded the 1991 Harold E. Edgerton Award, which recognizes young faculty members for outstanding achievement in research, scholarship, and teaching.

Kardar, who is the Class of 1948 Professor, will receive an honorarium of $5,000. The award was established in 1983 with faculty contributions in honor of Doc Edgerton, '27, who died last year. Kardar's "extraordinary talents and commitment in physics research," reads his citation, "are matched by his talents and commitment as a teacher, by his good citizenship within the Institute community, and by his general friendliness, selfless helpfulness, and dignified modesty."

Kardar has focused his recent work on the static and dynamic properties of surfaces, interfaces, paths, and polymers. "By developing a continuum field theory for random manifolds, such as polymers and membranes, he established the roles of elasticity, rigidity, and interactions in determining the macroscopic phases of such objects," the citation said. This work, together with his research on interfaces and paths in random media and on evolving interfaces, "have received wide recognition, as seen by recent invited lectures by him in Belgium, Brazil, Colombia, France, Hungary, Italy, and the Netherlands."

In addition to his prolific writing, Kar-

PHOTOS: FRANK REVI/MIT NEWS OFFICE

dar was praised for the graduate statistical mechanics subject that he developed and now teaches. "He attracts an audience from the Departments of Physics and Chemistry as well as Chemical, Electrical, and Nuclear Engineering," not only from MIT but from Harvard, BU, and Brown as well. In 1990 Kardar received the Graduate Student Council Departmental Teaching Award for this course sequence.

Kardar has served as a Fellow at Ashdown House for three years and has taken groups of students to symphonies, ballets, basketball games, and on hikes. He holds bachelor's and master's degrees from Cambridge University, and recently received a Presidential Young Investigator Award. □

Birgeneau New Dean of Science

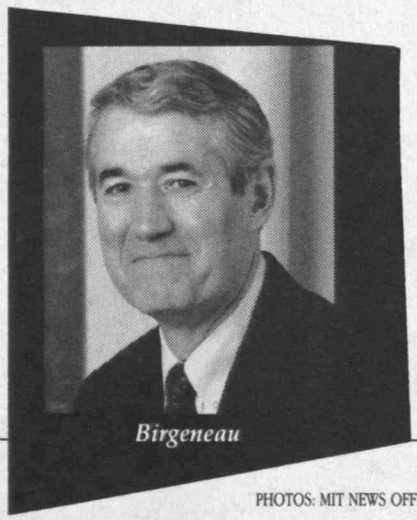
Cecil and Ida Green Professor of Physics Robert J. Birgeneau, head of the Department of Physics since 1988, has been named dean of the School of Science. He succeeds Professor Gene M. Brown, former head of the Department of Biology, who will return to teaching and research after six years as dean.

A leader in condensed matter physics, Birgeneau has been involved in a series of experiments, with colleagues from his department and the Center for Materials Science and Engineering, aimed at explaining high-temperature superconductivity.

In announcing the appointment, Provost Mark Wrighton commented that Birgeneau "has the stature as a scientist and the administrative capability to effectively lead the School of Science. He has a well-established track record of enhancing the participation of women and minorities in science and is dedicated to excellence in education and research."

Birgeneau received a BSc from the University of Toronto in 1963 and a PhD from Yale in 1966. Following a year as a postdoctoral fellow at Oxford he joined the technical staff at Bell Laboratories in 1968, where he was engaged in neutron scattering research. He left Bell in 1975 when he joined the MIT faculty. Birgeneau has been a guest scientist at Brookhaven National Laboratory since 1968.

Birgeneau's principal research interest has been the phase-transition behavior of novel states of matter. In the early 1980s, under the aegis of the Research Laboratory of Electronics, he and his colleagues carried out seminal experiments at the Stanford Synchrotron Radiation Laboratory that pioneered the use of X-ray radiation for high-resolution studies of condensed matter. □



Birgeneau

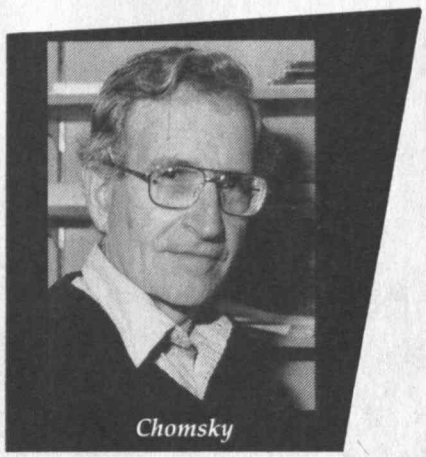
Chomsky Named Killian Lecturer

This year's Killian Award Lecturer is Institute Professor Noam Chomsky, internationally known both for his theories on the nature of language, which have revolutionized linguistic science, and for his political activities and writing.

The James R. Killian Jr. Faculty Achievement Award recognizes extraordinary professional accomplishments and service to MIT. It was established in 1971 as a tribute to the late MIT president and former chair of the Corporation. The award carries an $8,000 honorarium and its recipient usually delivers a lecture in the spring term of the award year.

Chomsky's selection was announced at the May faculty meeting by Professor Uttam RajBhandary, chair of the selection committee. The other members were Professors Mildred Dresselhaus, Morris Halle, Karen Polenske, and Alexander Rich.

The award committee's citation described Chomsky as "the recognized leader in the scientific study of language," whose scholarly work has "transformed linguistics from a huge but ineffectual accumulation of imperfectly understood facts into a coherent empirical and theoretical science. Because of the special character of language, these advances in linguistics have had far-reaching repercussions in a number of other disciplines, ranging from philosophy to biology."



Chomsky

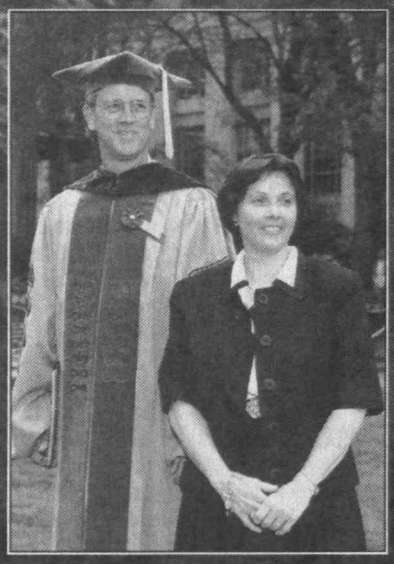
The citation continued, "Chomsky's ideas have also materially influenced research in certain domains of computer science as well as the study of visual perception. Less known perhaps is the influence that Chomsky's linguistic ideas have exercised on the field of immunology. The Danish Nobel laureate, Niels Jerne, has written in his Nobel lecture that in his account of the ability of our immune system to recognize antigens entering our body, he was influenced by Chomsky's account of language acquisition as based on innate universal characteristics of the human brain."

Of Chomsky's "second career" as "political commentator and activitist," the committee said: "His criticism of the actions of government and of press for the way in which it has reported these actions have received world-wide attention. They have also disturbed many. Chomsky's response has always been that it is the responsibility of intellectuals to speak the truth as they see it and that the reaction to his views is less due to the content of his message than to the effectiveness of the media in manufacturing consent."

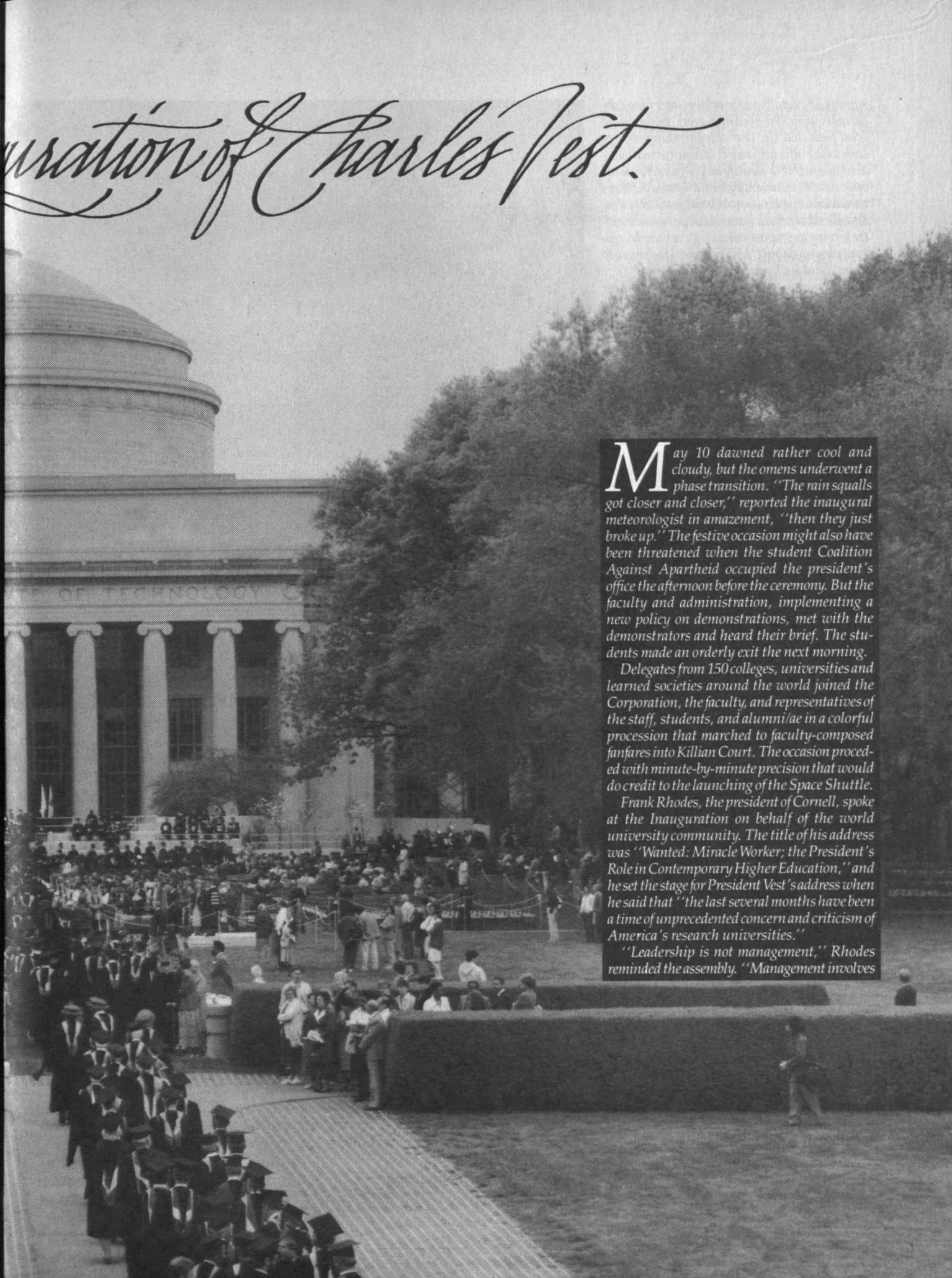
Chomsky has been a professor at MIT for 36 years. In 1988 he won the Kyoto Prize in the basic sciences. □

PHOTOS: MIT NEWS OFFICE/JOHN COOK

The Inau



uration of Charles Vest.



May 10 dawned rather cool and cloudy, but the omens underwent a phase transition. "The rain squalls got closer and closer," reported the inaugural meteorologist in amazement, "then they just broke up." The festive occasion might also have been threatened when the student Coalition Against Apartheid occupied the president's office the afternoon before the ceremony. But the faculty and administration, implementing a new policy on demonstrations, met with the demonstrators and heard their brief. The students made an orderly exit the next morning.

Delegates from 150 colleges, universities and learned societies around the world joined the Corporation, the faculty, and representatives of the staff, students, and alumni/ae in a colorful procession that marched to faculty-composed fanfares into Killian Court. The occasion proceeded with minute-by-minute precision that would do credit to the launching of the Space Shuttle.

Frank Rhodes, the president of Cornell, spoke at the Inauguration on behalf of the world university community. The title of his address was "Wanted: Miracle Worker; the President's Role in Contemporary Higher Education," and he set the stage for President Vest's address when he said that "the last several months have been a time of unprecedented concern and criticism of America's research universities."

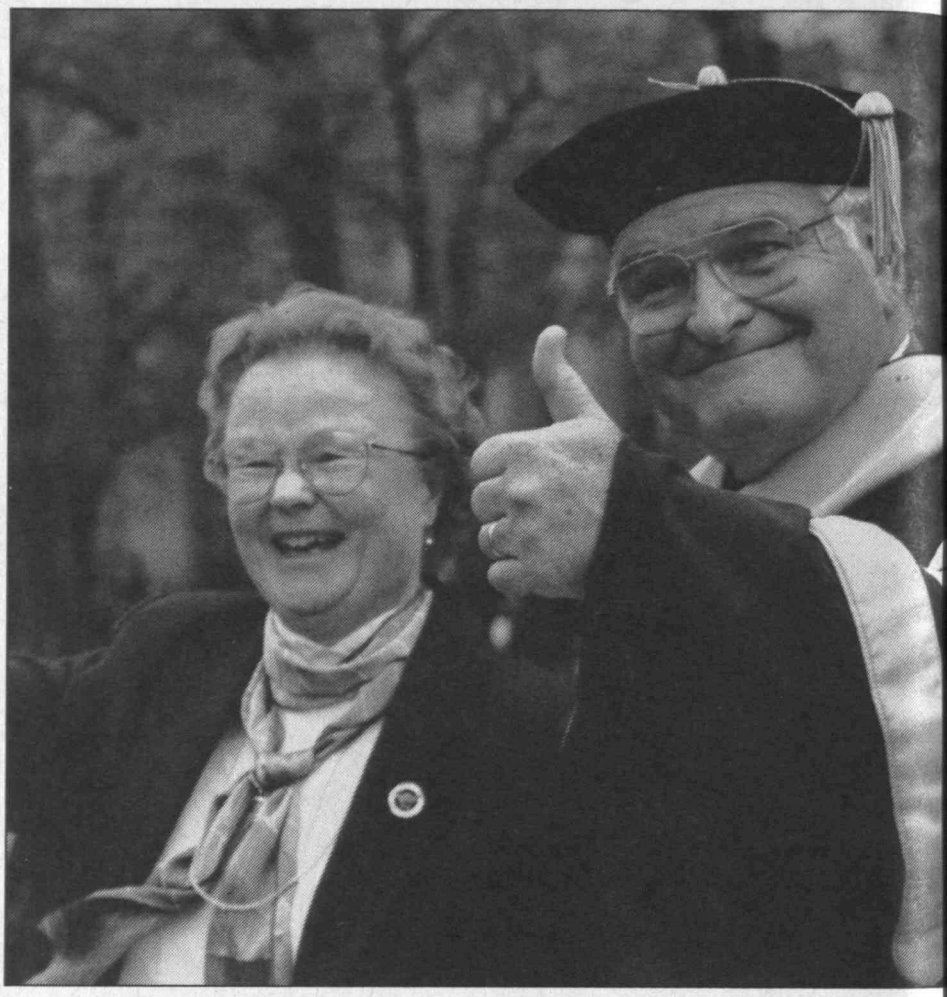
"Leadership is not management," Rhodes reminded the assembly. "Management involves

supervising details and presiding over the established routine. We need managers, and we need good ones, but the task of leadership involves something infinitely more. It requires individuals who are able to identify larger goals, to see the opportunity in adversity, and to kindle in others the passion of their own commitment." Rhodes, who like Vest came to a university presidency after serving as provost of the University of Michigan, observed that "MIT is indeed fortunate to have found such a leader in Chuck Vest."

Rhodes was followed by the MIT Chamber Chorus, then by Professor of Literature Stephen Tapscott, who delivered a 12-minute poem of welcome to the new president. Twelve minutes is a lot of poem. The possibility of thousands of people fidgeting in their seats for 12 minutes was enough to give the inaugural planners a collective anxiety attack, but Tapscott's joyful, sage, and funny ode was a high point of the day.

Tapscott reminded Vest that a faculty member seeming to sleep through the ceremony was probably doing problems in her head. He quoted Bertrand Russell: "From the outside it is impossible to tell the difference between a mathematician thinking and a mathematician sleeping." But "this is the behavior of authentic welcome," Tapscott affirmed. "Because this is the faculty, expressing the experiential fact of their welcome. . . This after all is what they do: they work."

And then Paul Gray, 54, as chairman of the Corporation, assisted by Presidents Emeritii Howard Johnson and Jerome Wiesner, invested Charles M. Vest as the 15th president. An abridged version of Vest's Inaugural address follows.



A View of the Challenges; a Vision of the Opportunities

MIT has played a remarkable role—at critical moments—in shaping our nation and our world. We have done so through individual creative genius and through grand institutional ventures. Like America itself, we have responded in an heroic and innovative manner to sudden challenges, such as the onset of World War II or the launching of Sputnik. Today we are challenged once again on a grand scale. But this time by slow, corrosive forces rather than by sudden, galvanizing events. By the erosion of our global environment rather than by explosions at Pearl Harbor. By declines in scientific literacy and industrial competitiveness rather than by the launching of a satellite.

This morning I would like to share with you my view of the challenges that confront us and to offer a growing vision of the opportunities they offer for the future of MIT.

A New Global Age

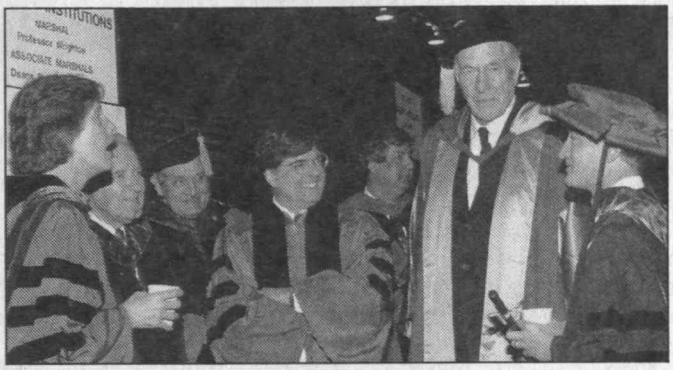
There is a remarkable image etched in the mind and psyche of our generation. We were the first to view a shimmering, seemingly peaceful planet Earth from the depths of space. Still, here below, we know that we inhabit a raucous global village. We are connected across time and space as never before in human history. Many of these connections have been made possible by the advances in science and technology. We must learn to deal with this interdependence in new ways, creating new forms of organization and incorporating new points of view.

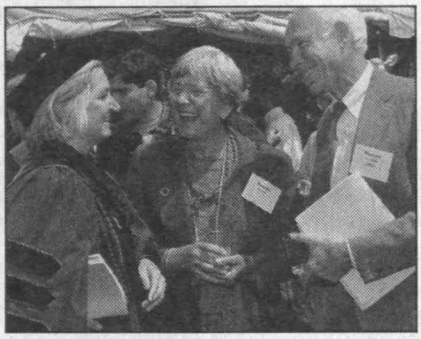
Let me give three examples.

First, the earth's environment. . . a fragile envelope that bears witness to the degrading effects of human activity. It is no longer possible, if it ever was, for individuals or nations to think that the way in which they treat their land, air, or water has no bearing on their neighbors. Nor is it possible for us to work on each aspect of the damaged environment as a separate problem. Ironically, many of the scientific and technological advances that so enhance human comfort and well-being concurrently pose threats to our biosphere.

This presents a challenge and an opportunity for us here at MIT. I believe that we must marshal our interests and capabilities to understand these issues and develop solutions. Such an endeavor will require a new generation of scientific computation for atmospheric modeling, new instrumentation for monitoring environmental conditions, new modes of analysis, and new technologies to

PHOTOS: JD SLOAN/TONY RINALDO CALLIGRAPHY: LISA TARCA





Clockwise from left: Priscilla and Paul Gray, '54, he resplendent in new robes as chairman of the Corporation. Towering in physical stature as well as in academic renown, economist John Kenneth Galbraith enjoyed a pre-ceremonial chat with (l to r) President of Wellesley Nannerl Keohane, MIT Professor of Biology Gene Brown, MIT Professor Emeritus Carl Kaysen, President of Yale Benno Schmidt, and MIT Provost Mark Wrighton; (just behind Schmidt is MIT Dean of Social Sciences and Humanities Philip Khoury.) Warren Briggs, '56, and his wife (center) were among the guests at the Inaugural Reception. Carl Mueller, '41 (directly above), chair of the Presidential Search Committee.

correct or avoid problems.

Beyond this, we need to come together in new ways to understand not only the physical, but the cultural, economic, and political forces that affect the health of the natural world. The stage has been set at MIT by the establishment of the Center for Global Change Science and by a new Council on the Global Environment. Only with this kind of integrated approach—drawing on faculty from disparate fields—can we hope to meet the profound challenge of making and keeping our planet livable.

Another challenge—and set of opportunities—in our increasingly interdependent world lies in the realm of electronic communications. Instantaneous communication has reduced our planet to the electronic global village envisioned by McLuhan. Bits of information flowing through copper wires, optical fibers, or satellite links have become a new currency: the currency of the information marketplace. Increasingly, the commerce of this new marketplace will be conducted along fiber-optic information superhighways that will connect computers, telephones, high-definition video systems, and hybrid technologies yet to be developed.

This information infrastructure already exists in rudimentary form. MIT has the opportunity to play a pivotal role in bringing increased capabilities and coherence to this system, and in defining the currency of the new information marketplace. In doing so, we must not only increase the power and ease of computing and communications, but we must do so in ways that enhance our intellectual and social capabilities, that help us make wiser decisions, and that enable us to bridge cultural and political barriers. Here, too, MIT must invent new ways of combining talents across disciplinary and institutional boundaries in order to give form, substance, and humanity to the dawning information age. To this end, I am pleased to announce the establishment of the MIT Information Infrastructure Initiative, a project that will bring together eight different organizations within MIT with the goal of working with industrial partners to develop a very high frequency, entirely optical network and to establish within our campus a working model of the information marketplace.

My third example derives from the increasing political and economic connections throughout the world. And that is: will the MIT of the future be a national or an international institution? What does it mean for MIT to be a citizen of a world where common problems or interests are often more powerful than geographic distances, yet where national differences exist?

The issue is complex. MIT is a national institution. Born as a manifestation of Yankee ingenuity and know-how, MIT has served as a driving force for the creation and improvement of American industry, is funded to a significant extent by the American taxpayer, and above all is centered on the education of many of the brightest and most talented young people of the United States.

Today, however, in order to serve

America well, we must participate in the broader global community. Basic science has always prided itself on being the prototype for true international cooperation, but today this viewpoint and system are under strain because of the increasing economic value of university-generated knowledge and technological concepts. There are those who look at this country's position on the economic balance scales and call for greater protection of our ideas, especially those having to do with science and technology.

Clearly, [MIT] must be concerned with this nation's economic well-being. We must not, however, endanger the very essence of our institution by retreating into simplistic forms of techno-nationalism. To draw boundaries around our institution, to close off the free exchange of education and ideas, would be antithetical to the concept of a great university. The list of nations that, at difficult historical moments, closed their universities to the outside world is not one [the United States] would be proud to join.

This does not mean that [the Institute] could not, on occasion, establish special programs directed at the solution of national problems. However, any such programs must also fit one fundamental rule: all students, once admitted to MIT, must be able to participate fully in our educational and research programs, without regard to their citizenship.

In my view, a much more important concern of MIT should be the establishment of programs to ensure that our students are prepared to lead full, responsible lives as world citizens. It is time we made the matter of international context and opportunity an integral part of an MIT education.

The Changing Face of America

Just as we develop new connections among nations, so too must we seek new connections within our own. Our society is increasingly pluralistic, yet our connections across racial, ethnic, and sometimes even gender boundaries are frayed. The nation's potential will not be fully realized until [all its citizens] have a full opportunity to realize their own potential and to contribute to the health and vigor of our society.

MIT has traditionally educated engineers, scientists, and others to develop technologies, lead businesses, and serve as professors, researchers, and scholars. To continue this leadership in the era ahead, we must better reflect the changing face of America in our students, faculty, and staff.

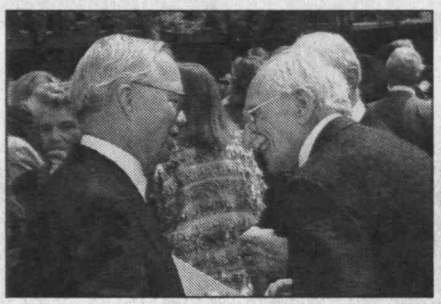
We must double and redouble our efforts to attract the brightest and best from all races, both women and men, not only to our undergraduate program, but to our graduate school and to our faculty. There are many social and historical forces mitigating against success in this endeavor. It will require renewed commitment on the part of each of us to identify and recruit these scholars and to do our part to see that they attain their full potential once they are here.

As one step, we will begin implementing during the coming weeks a program proposed by the Equal Opportunity Committee to recruit more women to our faculty. And we will reaffirm and reinvigorate our policies and programs for bringing more underrepresented minority members to our faculty. As we succeed, and in order to succeed, we must work to ensure that MIT is a place that respects and celebrates the diversity of our community.

Education: To Move a Nation.

America's colleges and universities stand as national treasures. But the strength of these institutions is imperiled by the state of our primary and secondary schools, and imperiled by the declining interest and ability among our young people to pursue advanced studies, particularly in science and engineering. These trends must be reversed.

Education can move a nation: the future belongs to those who understand it. Active, informed participation in our economy and our democracy now requires an ability to understand basic scientific and technical concepts. And yet, American popular culture pushes us in the opposite direction. We need no less than a change in the culture of this country, a revolution in attitude about the



Top: Inaugural concert-goers (from left) Jean and Milton Slade, '48, and Mary and Bob Cowen, '49. Above: President Emeritus Howard Johnson (left) enjoyed the Inaugural Reception with Professor Emeritus William Allis.

Head table guests at the Inaugural Luncheon included (from left) outgoing Harvard President Derek Bok, United States Senator Ted Kennedy, President Vest, and Carl Mueller. In his remarks to some 1,650 guests, Kennedy commented that: "If MIT were for sale, every other nation in the world, plus 49 other states, would want to buy it, regardless of price."

importance of education and, in particular, of scientific and mathematical literacy.

Until we, as a nation, wake up to the fact that we must increase our investment in the growth of human capital—in people and ideas—our educational system will spiral downward, pulling our economy and our way of life with it. This is a danger of the first magnitude and we must all work to address it.

Thirty years ago, MIT played a key role in launching a nationwide wave of education reform in the sciences. The time has come again for us to place our expertise and stature in the service of a major national effort to rebuild the strength of science and mathematics in American schools. I believe that MIT not only can, but must, draw on its special strengths to help renew effective, accessible education for the young people of this country.

An MIT Education for the Future

The education that we most directly influence, however, is the education of our own students. It is through these students that MIT will have its greatest influence on the world of the future. In recent years, our faculty has been involved in a long-term review of the undergraduate program. The intensity of this review is testimony to the fact that education, and particularly undergraduate education, is at the very core of MIT.

No one has been more engaged with these matters over the years than our engineering faculty. Indeed, the engineering curriculum in this country was largely developed by MIT faculty in the 1950s and 1960s, [when] they spearheaded the infusion of basic science into engineering education and practice.

The results were astounding: we produced engineers who created a revolution in computing and communication, developed vehicles to explore outer space, and started not only companies, but entire industries based on high technology. While this curriculum has been continually refreshed, its fundamental approach and content have remained essentially unchanged for 30 years. The world in which engineering is practiced, on the other hand, has changed dramatically and rapidly.

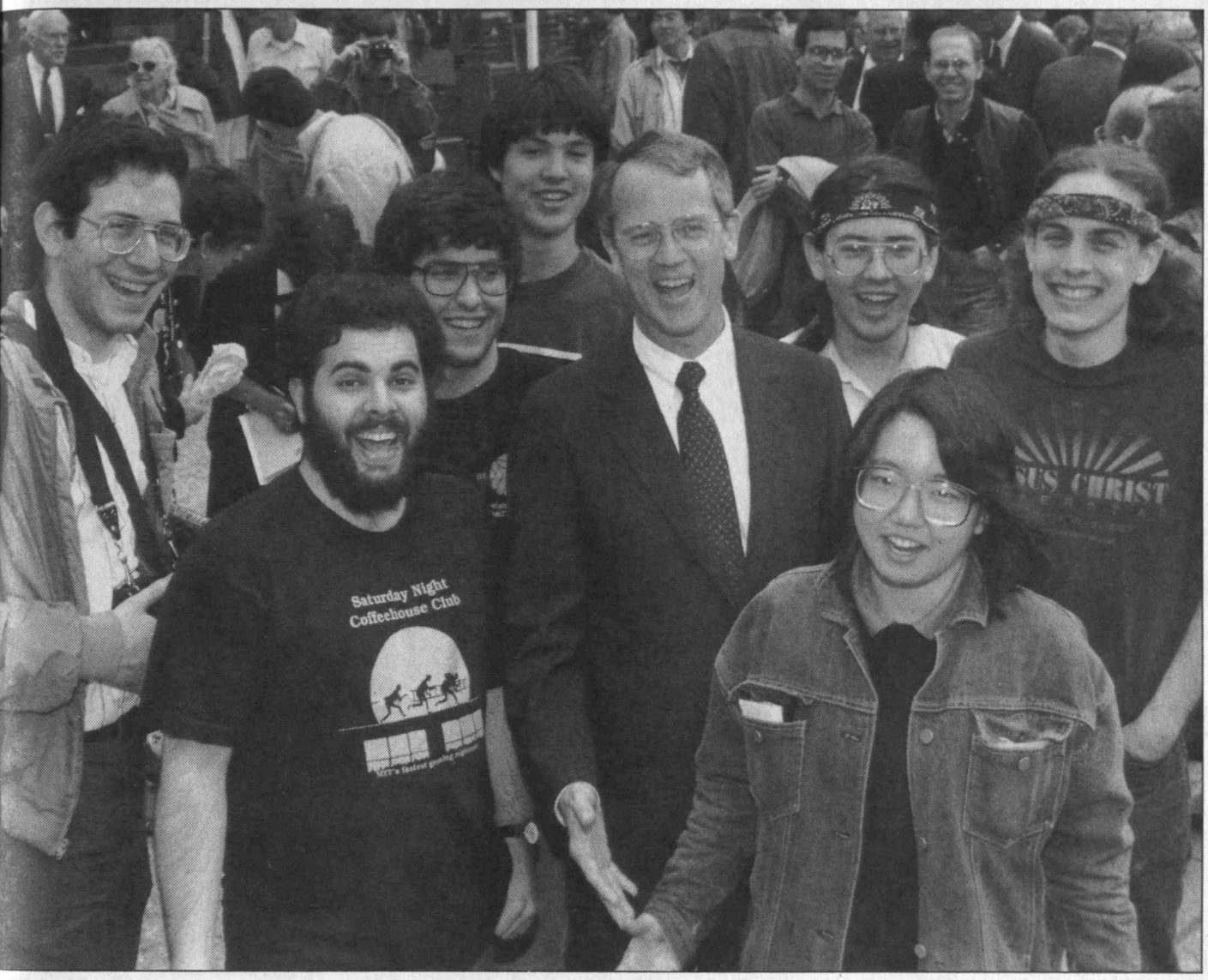
Take, for example, the decline in the United States' ability to compete in the world marketplace for manufactured goods. The reasons for this decline are complex, but a major issue has certainly been the attitude of industry and of universities toward the design and manufacture of consumer products. We need to infuse our engineering students with an increased respect for and enjoyment of effective, efficient, and socially responsive design and production.

This is but one of the challenges to engineering education that face our faculty as they design a curriculum that will serve our students well into the 21st century. They do so in the setting of this research university: a unique blend of graduate education, undergraduate education, and research [that] creates unparalleled opportunities for learning and for discovery. [I believe it is] a setting that keeps both our education and our research forward-looking and robust.

All do not agree with this view. Many believe that our mission has become distorted, and that education has been lost in our desire and responsibility to excel in research. This is clearly a central issue for MIT. As an event of the Inaugural year, we will hold a major colloquium on the topic of teaching and learning within the research university. I intend this to be a no-holds-barred debate that will illuminate our efforts to shape the future of education at MIT.

Educational success at MIT depends, above all else, on the commitment and inventiveness of our faculty. Excellence in undergraduate teaching must be rewarded and encouraged. To this end, we are establishing an endowed program to recognize faculty members who have profoundly influenced our students through their sustained and significant contributions to teaching and curriculum development. A select number of faculty will be appointed as Faculty Fellows, each for a 10-year term, and will receive an annual scholar's allowance throughout their appointment. The first fellows will be appointed this

Top: Enjoying a reception in the garden of the president's house were (from left) University of Michigan Professor Henry Johnson, Christella Moody and husband, Boston Attorney Charles Moody, and President of Morehouse College Willie Davis. Above: A notable runner in the Inaugural Road Race was Kemper Vest (center above), the president's daughter. Their attire was informal, but their Inaugural spirit was totally appropriate: (right) the President with students.



year, and we expect their ranks to build to at least 60 during this decade.

Today, science and technology, culture and policy, industry and government, production and communication are interwoven as never before. The nation needs broadly educated young men and women to be leaders of the next generation. An understanding of science and technology is surely part of what such leaders must possess. Similarly, those who practice science and technology need an ever greater understanding of the world in which they will work, and they must be able to contribute wisely to policies affecting the development and uses of technology.

What does this mean for education at MIT? Surely it means a careful balance among the humanities, arts, and social sciences on the one hand and mathematics and the physical and life sciences on the other. And it means a continuing look at our departmental programs to ensure that they give our students the best possible foundation for intellectual growth and professional achievement.

While the continuum from the humanities to the natural sciences has long been recognized, the continuum from humanities to engineering is less well explored. In general, such exploration in my view has been hindered by a utilitarian view of the humanities and social sciences on the part of many engineering educators, and by a lack of appreciation of the intellectual content of modern engineering by many humanists. An MIT education should enlarge an individual's choices—and so should include a common experience in the sciences and mathematics, a serious exploration of the humanities, arts, and social sciences, and a continuing conversation among these fields. I believe that the creative tension generated by these varying interests and cultures can serve us well as we continue to review and renew our undergraduate program.

But we should not expect to be all things to all people. One of the great strengths of the American educational system is the great variety of public and private colleges and universities. This condition allows for, and indeed demands, experimentation, variation,

cooperation, and competition. The resulting synergy is the yeast that keeps our system strong.

Rebuilding Trust in Science and Technology

For four decades, the American research universities have paid enormous dividends in the form of educated leaders in academia, business, and government. . . advances in medical care and nutrition . . . national security. . . new and revitalized industries. . . increased understanding of our physical, social, and natural worlds. But today, the American public is questioning the value of our research universities. It no longer tends to view science and technology as the foundation of progress. The public's attention is caught not only by the debate over the costs and quality of undergraduate education, but by the debate over the costs and conduct of research.

The doubt of the moment, however, must not be allowed to weaken the basic concept of the American university system, one that is universally recognized as being the best in the world. This system is founded on a social contract with the American public and enhanced by partnerships with government and industry. We cannot keep our flexibility, our vigor, our quality—as a nation or as an academic community—by taking this partnership for granted.

[It is time] to rebuild trust in this nation's research universities and its scientific enterprise. We must ensure that the foundation of scientific and scholarly research is secure. What is this foundation? Jacob Bronowski stated it with deceptive simplicity when he wrote, "The end of science is to discover what is true about the world."

In seeking scientific truth, ideas and hypotheses are debated, tested, proved, disproved, revised, built upon, or rejected. This activity is carried out by researchers in different laboratories, different universities, different countries. This is what makes science, indeed most scholarship, simultaneously an individual and a communal activity. And it is why we have usually been able to rely on this system to detect and correct error.

Like all human endeavors, science is not, and cannot be, totally free from error or even occasional abuse. And so it rests upon us as scientists and scholars to do a better job of strengthening, renewing, and transmitting our values. We must impart a passion for integrity and ethical rigor in the pursuit of truth. But whatever we *say*, ethical lessons will be taught primarily by the ways in which we undertake our own scholarly activities.

These lessons will also by conveyed by the ways in which our institutions handle problems if they do arise. How we deal with alleged misconduct will affect the strength of society's confidence in and regard for our universities and colleges and for the enterprise of science. We have heard recent outcries for and against the policing of science. Our response, as an academic community, must not be one of knee-jerk defensiveness against our critics. Rather, we must engage seriously with thoughtful critics as well as with our colleagues to foster academic integrity and deal forthrightly and fairly with problems when they arise. If we are not able to do so, we can be sure that others will be only too glad to do it for us.

Public confidence in U.S. universities must be fully restored. Our social compact must be reestablished. But in the discourse required to do so, we must avoid the trap of justifying all that we do on utilitarian grounds. Clearly, [universities] have been great contributors to the nation's economy, and this must continue to be a cardinal element of MIT's mission. But if we over-emphasize these contributions as the justification for investing in universities, we might unwittingly endanger our traditions of intellectual excellence, innovation, integrity, openness, service, scholarship, and independent criticism. Ultimately, our contributions to social progress and well-being rest on our ability to steer our own course with imagination and intellectual daring.

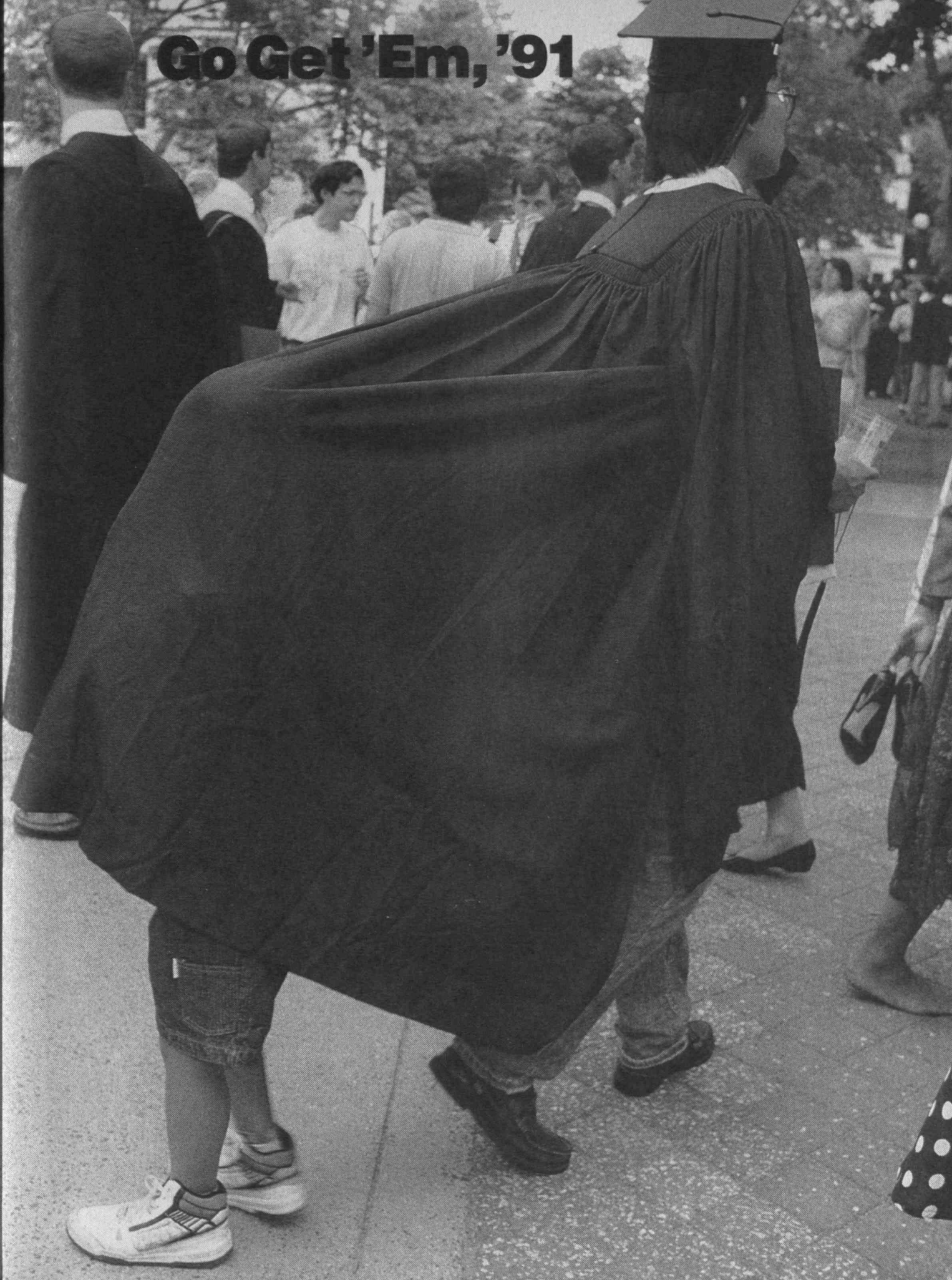
What then is my vision of MIT a decade hence?

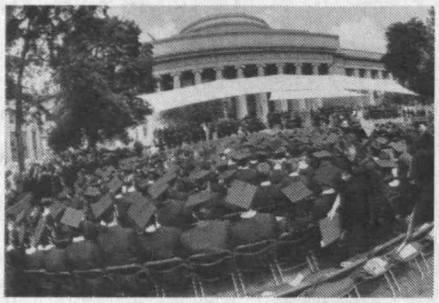
MIT will be a preeminent wellspring of scientific knowledge and technological innovation. MIT will foster the pursuits of individual scholars, whose work so often leads to truly fundamental discoveries. We will be known for our ability to establish new methods for analyzing complex and pervasive issues facing the nation and the world. In an invigorated partnership with industry, government, and other educational institutions, we will contribute profoundly to [resolving those issues.] MIT will be known for educating engineers who combine the spirit of innovation and invention with a passion for the highest quality and efficiency in design and production.

MIT will better reflect in our students, faculty, and staff the changing face of America. We will find ways to instill the excitement and romance of science and mathematics in new generations of young people. MIT will spearhead efforts to rekindle our nation's belief in the importance of scientific research and education. We will have found renewed commitment to the deepest values of the academy. MIT will stand for integrity in all that it does. MIT will serve our nation well, but also will be of and for the greater world community.

Above all, the Massachusetts Institute of Technology will be a place to which the brightest young men and women will come for their educations. They will be able to attend MIT regardless of their financial circumstances. They will be taught and counselled by dedicated teachers who themselves define the leading edge of human knowledge and invention. The education of our students will be robust: deep in scientific content, yet providing the flexibility and learning skills to serve them well in ever expanding circumstances. Through that wonderful blend of undergraduate education, graduate education, research, and creative activity that is MIT, our students will be enriched and they, in turn, will enrich the Institute.

Mens et manus: With mind and hand we set forth. Our promise will be secured by the collective energies and wisdom of those who are drawn to this great magnet for intellect and creativity. Together, we will give shape to the future—the future of MIT, our nation, and our world. □


Go Get 'Em, '91



Commencement was not unlike the Inauguration. But there were some important departures, most importantly, the participation of 1,773 graduates of 1991. Commencement speaker was NSF Director Walter Massey (above); the procession was led by President of the MIT Alumni/ae Association Christian Matthew, '43 (above right with mace); and of course, families came from around the world.

The graduates of '91 were a busy lot: although they numbered only 1,773 seniors and graduate students, they went home with 1,964 degrees. At the June 3 ceremony, President Charles Vest and Provost Mark Wrighton presented a total of 976 bachelor of science degrees, 216 doctorates, 747 master of science degrees, and 25 engineer degrees.

The steady rhythym of names being read by the deans of each school was punctuated by small bursts of cheering from families and friends, the click and whirr of still and video cameras, and the pop of the occasional champagne bottle. With the "hooding" of doctoral candidates on the previous Sunday in Rockwell Cage, the multihour pageant was kept as streamlined as possible.

President Vest's "charge to the graduates" met all the requirements for such an address: an inspirational message delivered with brevity and lightness. There was, of course, truth as well as humor in his reference to the graduation season as a time "of parties, platitudes, and platforms." But Vest was not the only person in Killian Court who hoped that the graduates would take his call to careers marked by public service as much more than another platitude. He was certainly not the only person convinced that a priority for the Class of '91 should be to help bridge the gap between rich and poor, between those who are full players in U.S. society and those who are "rendered impotent."

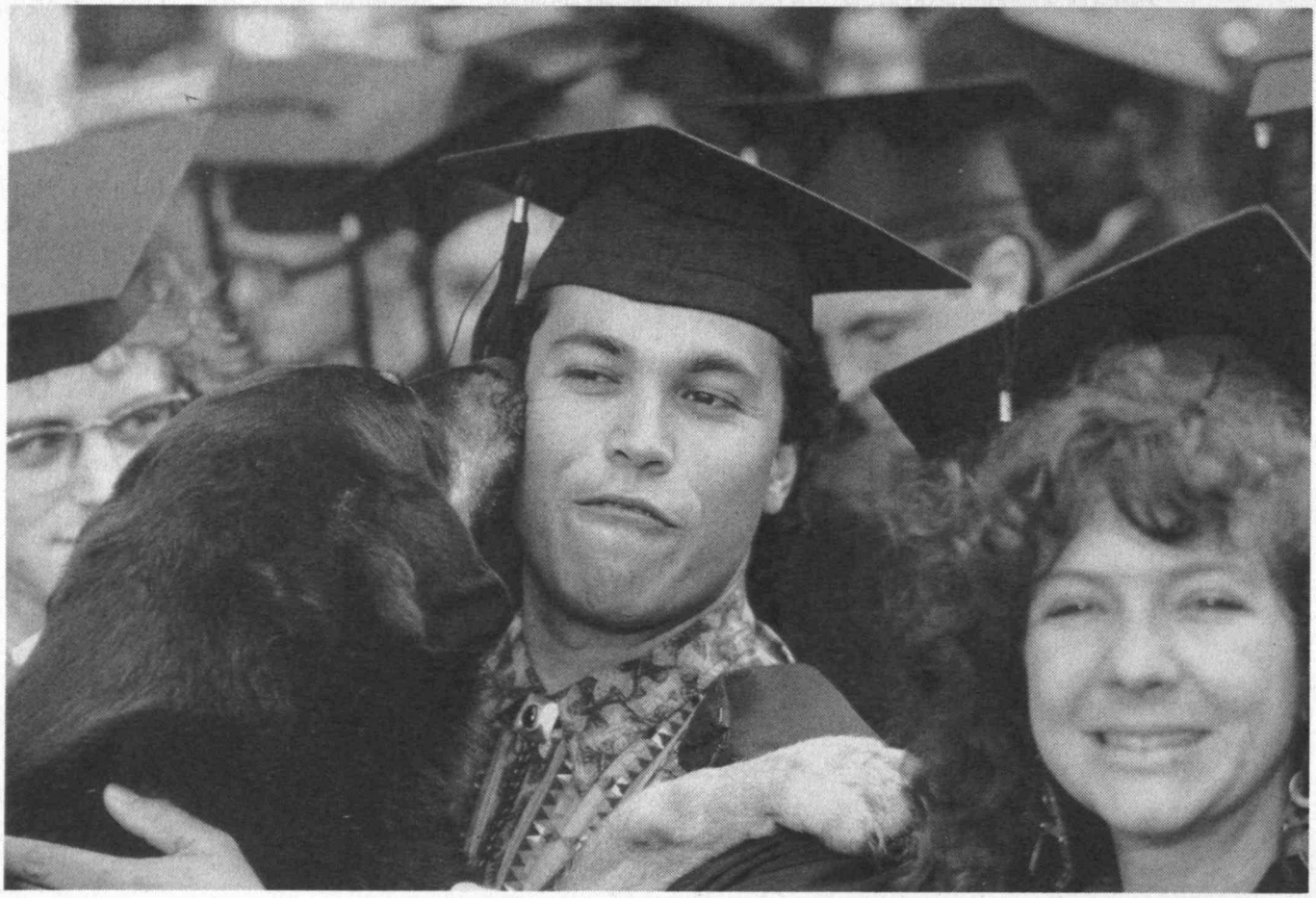
The president told a story that reflected a wise perspective on how important official messages are—or are not. A man came to President Emeritus Jerome Wiesner a few years ago, Vest recounted, and said, "Dr. Wiesner, do you remember me? You shook my hand at graduation 20 years ago, and you said something to me as I came through the line to receive my diploma that changed my life. It was the secret of my successful career." As Vest went on to explain, Wiesner reluctantly admitted that he didn't really remember the man and asked "Well, my goodness, what did I say?" "You said 'keep on moving. . .keep moving,' " the alumnus replied.

Vest put a fillip on the traditional finale of the charge to the graduates that should endear him to wearers of brass rats: "God speed . . . Good luck," he said, then added, "Go get 'em!"

Keynote speakers, on the other hand, are expected to go on at some length in a more serious vein, and Walter Massey, the new director of the National Science Foundation, certainly has a lot of high-profile issues on his plate that are of concern to the university community.

At the top of the list is scientific integrity, recently thrown into sharp focus by the case of alleged fabrication of data in a paper on which biologist David Baltimore, '61, was a co-author (*see article on page MIT 20.*) "Like Caesar's wife, universities must be above reproach in all conduct relating to

PHOTOS: PAULA LERNER



research," Massey said. "Individuals conducting fundamental research depend upon the veracity of the accumulated insights and accomplishments of others. . . . Few things are more damaging to the research enterprise than falsehoods."

Massey contends that ideally, young scientists learn values along with science in mentor-apprentice relationships with their advisors, relationships that are diminished in the move "away from small, tightly knit research communities. . . toward large, anonymous research enterprises, in which tasks are fragmented and accountability is hard to ascribe."

Massey reflected the opinion of the scientific community when he said that "Scientists and engineers are the only people who can redress misconduct. Universities, as the primary locus of basic research, have a special responsibility to analyze the facts, determine accountability, protect the rights of all involved, and see that falsehood is corrected."

Discussion of the responsibility of universities led Massey to the question of "allocating indirect costs," another issue that has propelled the academic community into the headlines. "As the costs of academic research increase, so too does the universities' dependence on federal support. As the federal investment grows, so too does the public's scrutiny of research universities. Misconduct of any sort imperils public sponsorship of research."

Massey confirmed "critical review by peers" and "publication in a peer-reviewed journal" as key safeguards of research integrity. "Deliberately bypassing the peer-review process" is an "incorrect behavior to be avoided," Massey said. Making specific reference to the cold-fusion controversy, he said that "the credibility of the entire university research enterprise has been jeopardized by the action of individual schools attempting to bypass peer review to obtain earmarked federal funds for their research facilities."

There must have been a certain irony in Massey's remarks for any researchers from MIT's Francis Bitter Magnet Laboratory who happened to be in the audience. Last August—before Massey took over—NSF bypassed the recommendations of its own peer-review panels that NSF award the National High Magnetic Field Laboratory to MIT. It approved instead the application of a consortium based at Florida State University.

Massey's address was a shopping list of the problems that can be encountered in research, but he ended on an upbeat. Those who engage in careers in research "join the pantheon of scientists and engineers who have changed the condition of life on earth and brought the universe to our doorstep," Massey said. "The possibility of observing or understanding what no one has ever observed or understood before can be irresistible."—*Susan Lewis* □

The 50-Year Reunion Class, in their new red jackets, always leads the graduates into Killian Court. Carrying the banner for the Class of '41 are (from left) David Saxon, past chair of the Corporation, and John Sexton, followed closely by Carl Mueller and Joseph Gavin. Bubbles have joined gowns, snappy dress uniforms, and hugs as classic Commencement photos, but this year's pets—like Elizabeth-Ann Carrell's correctly hatted pomeranian—were distinctive.

BY DAVID HAMILTON, '88

The Subtext—and Context of the "Baltimore Case"

Surely one of the unlikeliest sources for a steady stream of media reports over the past five years has been an arcane paper published in the research journal *Cell* in April 1986, under the title "Altered Repertoire of Endogenous Immunoglobulin Gene Expression in Transgenic Mice Containing a Rearranged Mu Heavy Chain Gene."

The only feature of the paper that might have caught the public eye was the name of one of its six co-authors: Nobel laureate David Baltimore, '61, then an MIT professor of biology and director of the Whitehead Institute for Biomedical Research.

The controversy that has swirled around the paper since then is widely referred to as the "Baltimore case," or even the "Baltimore scandal," and at its vortex were one of the paper's principal co-authors, Thereza Imanishi-Kari, a researcher at MIT who moved to Tufts University soon after the paper's publication, and Margot O'Toole, in 1986 a postdoc in Imanishi-Kari's lab.

For most of that intervening time, Baltimore, now president of Rockefeller University, led a vigorous defense against charges by O'Toole that the paper's conclusions weren't supported by any data Imanishi-Kari had collected. O'Toole's challenge was examined in turn by Tufts, MIT, the National Institutes of Health, a congressional subcommittee chaired by Representative John Dingell (D-Mich.), and the NIH's Office of Scientific Integrity (OSI).

The matter finally came to a head last March, when the media were leaked copies of a "confidential" OSI draft report finding Imanishi-Kari guilty of "serious scientific misconduct." Baltimore (and all the authors except Imanishi-Kari) retracted the paper, and a month later he issued a four-page apology to O'Toole and to the scientific community, saying he'd been blinded by an "excess of trust" in Imanishi-Kari.

The case has become a cause célèbre for observers of the research scene who say that universities are generally either unable or unwilling to investigate adequately allegations of scientific misconduct. There has been a stream of charges and counter-charges, often couched in the specialized language of immunology, and *Technology Review* has space for only the barest chronology.

A few weeks after the *Cell* paper was published, O'Toole was attempting a series of experiments designed to extend the paper's findings. But things weren't going well—a key reagent was giving different results than had been reported in the paper. Since the original research involved work with a line of genetically altered mice, O'Toole began searching through the breeding records, hoping to find an explanation for the anomalies she was turning up. Instead, she found 17 pages of data relating to experiments published in the original paper that simply didn't match what had been published.

Imanishi-Kari reportedly rebuffed her request to examine more of the original data, so O'Toole turned for help to a mentor from her graduate-student days at Tufts. After discussions within the biology department, a panel of Tufts immunologists led by Henry Wortis met twice with O'Toole and Imanishi-Kari to review the data.

Accounts of those meetings vary: the Tufts scientists say they listened carefully to O'Toole's contentions, looked at the data Imanishi-Kari presented, and decided that O'Toole was raising little more than a point of scientific disagreement—a far cry from serious misconduct, which O'Toole had not yet alleged.

O'Toole, however, alleges that at the Tufts meeting, Imanishi-Kari admitted that, as a result of inadvertant error, "a large series of experiments" described in the paper had never been done. At that point, O'Toole says, the Tufts scientists closed ranks behind their new colleague.

Meanwhile, O'Toole approached MIT's ombudsman, Mary Rowe, for advice. She says Rowe first pressed her to bring formal charges of fraud, but O'Toole declined, saying her information didn't warrant that charge. Rowe told her MIT could still handle the matter "in an ethical way." O'Toole was particularly concerned because her one-year, post-doctoral appointment at MIT was ending, and she feared that a non-tenure track appointment at Tufts might be withdrawn. "Dr. Rowe assured me that coming forward was the right thing to do, and that she would speak to the dean [of science, Gene Brown] and the chairman [of the biology department] and enlist them in making sure that a position would be found for me in an MIT lab," she told Dingell's subcommittee in 1989.

Rowe arranged for O'Toole to speak with Brown, who asked MIT Professor of Immunology Herman Eisen to undertake an "inquiry"—an examination of the facts to determine if a formal investigation was called for. After meeting with Eisen twice, O'Toole put her concerns in a memo, which Eisen distributed among the authors. The authors met with O'Toole and Eisen on June 16, 1986. In the two memos that Eisen wrote in reference to that meeting, he characterized O'Toole's concerns as "largely matters of interpretation and judgment." He recommended no further action.

Eisen and Baltimore have both testified under oath that they had given O'Toole a "fair and useful airing." They emphasize that O'Toole up to that point had not charged fraud, so they were justified in treating her challenge to the paper as a scientific matter, best handled through the normal procedure of experimentation, verification, and publication.

O'Toole tells a different story: Rowe, she says, had edited her memo to remove any hint that misconduct might have occurred. (*Technology Review* called Rowe about this point, but ombudsmen cannot comment on any specific case.) O'Toole also claims that at the meeting with the authors, Baltimore examined the 17 pages and "acknowledged that the published results could not be based upon them." Imanishi-Kari "again admitted that a large series of published experiments had not even been performed, and that some that had been performed had not yielded the claimed results." Baltimore, according to O'Toole's story, told her that such inaccuracies were "not unusual," and said he would oppose any effort she made to press for a correction.

O'Toole points to several pieces of documentary evidence that support her contention. The first is a September 9, 1986, letter from Baltimore to Eisen, in which Baltimore states that "after much thought," the "evidence that [a particular reagent] doesn't do as described in the paper is clear. Thereza's statement to you that she knew it all the time is a remarkable admission of guilt. Why Thereza chose to use the data and to mislead both of us and those who read the paper is beyond me." Baltimore added that he opposed a retraction, since it would harm David Weaver, the paper's lead author and a Baltimore postdoc, but that he would inform his colleagues that the reagent was un-

reliable. He concluded: "I, for one, will be skeptical of Thereza's work in the future." Baltimore now says this letter was triggered by a series of misunderstandings arising from the fact that English is Imanishi-Kari's fourth language. Once the misunderstandings were cleared up, Baltimore says, the letter became "inoperative."

O'Toole also questions Eisen's claim that her challenge "had all the hallmarks of a typical scientific dispute. O'Toole seemed to be analyzing methods and offering alternative explanations," he says. "Everyone loves to find something wrong with a scientific interpretation." But Eisen testified before Congress in 1989 that he kept the possibility of fraud in the back of his mind. "In dealing with her charges—Dr. O'Toole's charges of error—I was not unaware of the possibility that she had in mind fraud and was unwilling to say so, and in carrying out my evaluation, this concerned me. This was one of the reasons it took time." And Eisen's memo on the meeting over which he presided is titled, "Allegations of misconduct by Thereza Imanishi-Kari in a research study entitled 'Altered Repertoire...' "

Events since the June 1986 meeting have followed a tortuous path. The NIH completed an investigation in February 1989 that found "no evidence of fraud, conscious misrepresentation, or manipulation of data," although it criticized the authors for "lapses in scientific judgment" and "significant errors of misstatement and omission."

Meanwhile, Dingell had opened his own investigation, calling in the Secret Service to examine Imanishi-Kari's laboratory notebooks. At a hearing in May 1989, agents testified that many pages had been backdated—a finding Imanishi-Kari attributed to sloppy notekeeping. When Dingell called Baltimore to testify, the Nobel laureate turned the hearing on possible misconduct into a debate on whether Congress was the right place to adjudicate scientific disputes. According to one observer, "To the scientists in the room, Baltimore won the argument, but others could see that David had made a terrible mistake—he had humiliated Dingell in public."

Then the NIH's Office of Scientific Integrity decided to reopen its investigation—this time with the help of the Secret Service. Almost two years later, its work was complete. Forensic and statistical analyses showed that Imanishi-Kari had "fabricated" numerous sets of data, some of which had appeared in the paper, others of which she later provided to the OSI to support the paper's conclusions.

In the wake of the furor created by the widespread disclosure of the OSI draft report, Baltimore issued a public apology to O'Toole, praising her abilities as a scientist but minimizing his role in the affair. O'Toole then went public with her own four-page version of events, published in the May 16 issue of the journal *Nature*.

"David made a terrible mistake—he humiliated Dingell in public."

Two weeks later, again in *Nature*, Baltimore and Eisen fired back. In his statement, Baltimore claimed that the 17 pages are "irrelevant" to the science of the *Cell* paper—despite the fact that the criticisms in O'Toole's June 1986 memo are based almost completely on those pages. Eisen pointed out that O'Toole has changed significant details of her story since she first spoke to him in 1986, when, so far as he could tell, the matter was a routine scientific dispute that he handled as could have been expected. Eisen absolutely denies that Imanishi-Kari admitted at any meeting over which he presided that experiments had not been done or that some experiments had not produced the reported results.

There is surely more to come. Note the editors of *Nature*: "others who have signalled their wish to join this discussion will be accommodated as space permits."

As of this writing, OSI's formal report has not been made public, but it's safe to assume that the critical evidence of misconduct comes from the Secret Service reports. No one is suggesting that universities call in the Secret Service every time there is a scientific dispute. So the questions remain: did MIT take all the reasonable and appropriate steps in 1986, and what, if anything, should it do differently in the future?

Provost Mark Wrighton has established a faculty committee chaired by Sheila Widnall, '61, the Abby Rockefeller Mauze Professor of Aeronautics and Astronautics, to consider three general subjects: MIT's "community values" regarding the conduct of research; Institute "policies and procedures" regarding the conduct of research; and a comparison of these Institute regulations with those of funding sources. Finally, Widnall's committee is asked to suggest "innovative education and mentoring programs" that can raise "the conscientiousness of our community concerning issues associated with the conduct of research."

Widnall says the committee is unlikely to spend much time with the specifics of the Baltimore case, arguing, "I'm not sure we can learn much from a single example." Instead, she says, any problems that exist require a more systematic change in the "culture of the university."

Wrighton himself contends that "in any human undertaking, especially one where no records are kept of what was actually said, differences of opinion as to what was said can arise."

MIT followed existing procedures "scrupulously" in responding to O'Toole's charges, in the opinion of John Deutch, '61, who was provost until last October, but clearly that wasn't enough. "Any time procedures are followed and a mistake is made, one has to conclude the procedure is not adequate," Deutch said recently. He is hopeful that the committee chaired by Widnall can make checks of possible misconduct more accurate, but acknowledges that "it's not at all clear to me what I'd recommend as a fix."

Arguing scientific questions in Congressional committees and newspaper columns may be fraught with hazard, but Dingell's persistence *was* a critical factor in bringing important evidence to the attention of OSI. And by all reports, Dingell is not ready to quit. His aides are completing what they call a "who-knew-what-when" investigation into the way MIT and Tufts investigated O'Toole's allegations which is is due to become public sometime this summer. □

DAVID P. HAMILTON is a reporter for Science *magazine.*

CLASS NOTES

17

As I wondered what to include in this set of class notes, I had a call from **Ray Brooks.** He sounded just great. He seems to be "having a ball"—thanks to his friends who fly him to aviation events all over the country and also the continuing contacts from people and organizations wanting World War I background, especially since the Mideast conflict. Then the May/June issue of the *Review* arrived, and there was a full page article on Ray, complete with picture. (Page 15 in the MIT section in case you missed it.) Ray's eyesight is bad, so he listens to classical music and turns up the sound track (without picture) when he watches TV. So, if you call him and get no answer, try again a half hour later when he might hear the phone ringing.

I must report more losses in our ranks. **Leon Keach,** who graduated in architecture passed away in March. After graduation he won an MIT traveling fellowship and earned an advanced degree in architecture from the American Academy in Rome. He had retired in 1974 from the Boston firm of Campbell & Aldrich.

Roy J. Cook died in Buzzards Bay in late February. For more than 50 years and until his retirement he owned and operated Rex-Hide Inc., an international distributor of brake linings and automotive parts in Montclair, N.J. Roy's MIT degree was in electrochemical engineering. The company is now owned by his son, Roy, Jr.

Mrs. Walter **(Anna) Stubley** of Venice, Fla., passed away in February in Naperville, Ill. She had owned a real estate brokerage firm and was a member of the daughters of the British Empire, the Crippled Children's Association, and St. Paul's Anglican Church in Port Charlotte. Also she had been a member of the MIT Club of Southwest Florida.

I am ever hopeful of receiving news from other classmates. Don't make me do what one Ivy-League class secretary resorted to. When he had no real news from classmates, he wrote about the most outlandish escapades of a fictitious classmate until someone discovered the deception.—**Ron Severance,** acting secretary, 39 Hampshire Rd., Wellesley Hills, MA 02181

18

Your secretary was one of the 550 participants in the Inaugural Procession in cap and gown—all part of the induction of Charles Vest into the office of President of MIT on May 10, 1991. I was the only representative of our class. It afforded me the opportunity, however, to see again so many alumni whom it has been a privilege to know and work with for many years. The program will be reported in other pages of the *Technology Review*—suffice to tell you it was wonderfully well prepared and executed as is to be expected at MIT.

I received a newsy note from **Jim Niemeyer** of Boca Raton, Fla., who was a close friend of **Charlie Tavener**—naming a tower in a brand new development (called Mizner Park) for him—it's the Tavener Tower.

A welcome note from Irvine Ross, Jr., '30, from Fort Wayne, Ind., tells of life in Needham, Mass., my residence for the past six years. He described in an interesting fashion his life in this town where he was born and lived until 1942. I expect to retrace some of his steps.

Our condolences go to **Herb Larner** who advised me of the death of his daughter, Sally L. Will, on March 1, 1991.—**Max Seltzer,** secretary, 865 Central Ave., Needham, MA 02192

19

Sometimes things have to be different and so now if you want to telephone me our area code has been changed. It was 201, now it is 908. All you need to dial now is 908-234-0690. I invite you to try it. Our address otherwise remains unchanged.

In reviewing some statistics of our class I note that we have 29 living members in our class. In fact, I telephoned three of them yesterday and two answered their phones themselves and sounded strong of voice and with active minds. My first call was to **Douglas M. Burckett** in Lincoln Center, Mass. You may recall that he was one of those who attended our 70-year reunion. There was no answer to the ring so we presume he was away. Next we called **George Cann** of Gladwyne, Penn. We had a short talk and he told me he is 94 years old and for the first time in two years had a cold and did not know how or where he got it.

We asked as to his reading the *Technology Review* and he answered, "No, I'm totally blind." This did not bother our pleasant conversation. Then we called **Ralph A. Cartwright** who lives in North Hampton, N.H. He is 93-years old and still navigating. We too had a short but interesting chat and I found him easy to talk to. We plan other such talks to follow and am assured we had and still have a great class. Have a good summer.—**W.O. Langille,** secretary, P.O. Box 144, Gladstone, N.J. 07934

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Please send news for this column to: **Harold Bugbee,** secretary, #313 Country Club Heights, Woburn, MA 01801

21

Your secretary received a memorial leaflet October 10 of Anita Carley (Mrs. **LeRoy M.) Hersum** who died October 19, 1990. A graduate of Radcliffe College, she and LeRoy were married in 1925. LeRoy preceded her in death in 1971. Mrs. Hersum had worked at Harvard University for 40 years as secretary to the Dean and research assistant at the Business School.—**Sumner Hayward,** secretary, Wellspring House E64, Washington Ave. Ext., Albany, NY 12203; **Samuel E. Lunden,** assistant secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22 70th Reunion

Madeline F. Appel, the widow of class president **Parke D. Appel** died in Venice, Fla., April 17, 1991, at age 92. Her death occurred less than a year after that of Parke. She was a graduate of Simmons College, marrying Parke not long after receiving her degree. She is survived by their daughter Joan E. Appel of Venice. Madeline's death seems to bring to a close the era of organized 1922 class activities.

David H. Harris, 89, of Sarasota, Fla., died April 24, 1991, of accidental drowning. He went to Sarasota 15 years ago from Falmouth, Mass. He had been an industrial consultant. He is survived by his wife Edith E., two daughters, a son, and nine grandchildren.

Irwin B. Cassidy, one of the older members of our class having been born September 7, 1896, died May 29, 1989, in Lakewood, N.J. He is survived by his widow Joyce L. Cassidy. He entered MIT in his sophomore year from Toronto, Canada. The 1961 Register shows him to have been engaged in long range planning with Western Electric Co., in New York City. By 1967 he had retired.

Charles Borden Miller, Jr., from Goldsboro, N.C., died July 6, 1990, at Charlotte, N.C., at age 92. He had a master's degree in electrical engineering from Course VI-A. I believe his career was with the Duke Power Co. of Charlotte. He entered MIT as a junior after preparing at Virginia Military Institute. He was a member of Phi Gamma Delta.

Your secretary attended the inaugural ceremonies at the installation of Charles M. Vest as MIT's 15th president. It was a splendid occasion, well conducted and giving us confidence that MIT continues to be in good hands.—**Yardley Chittick,** secretary, Rte. 1, Box 390, Ossipee, NH 03864

23

As I write these Class Notes on May 23, I realize any comments on weather will be old in the reading. I look through the window and I see a maze of color from daffodils, tulips, dogwood (white and pink), azaleas, and many other flowers, with fruit trees blossoming and leaves of trees budding. Life is really wonderful. The spring temperatures have been unusually high, some days over 80 degrees.

Your secretary has received a letter from Paul E. Gray, Office of Chairman of the Corporation, enclosing a pamphlet concerning memorial gifts to the Institute which includes a list of donors by classes. I quote from his letter: "I have enclosed a copy of the 1989-90 *In Memoriam* which recognizes those in whose memory gifts were made from 1989 to June 30, 1991, and all in whose names endowed funds have been established since 1870." If this is not a general mailing, it is presumed one can be obtained by writing to the office, Room 5-206, 77 Mass. Ave., Cambridge, MA 02139.

Concerning the Class individually, I regretfully have to report on the passing of our classmates. **F.M. Perry** died on February 7, 1991. He was born in Camilla, Ga., on February 16, 1901. Other colleges attended were the University of Virginia and the University of Georgia. Mr. Perry worked as a real estate developer in South Jacksonville Beach, Atlantic Shores, and others. He also operated Perry's Book Store from 1939 to 1955. He is survived by his wife, Inez Hotsford Perry, two sons, a sister, and numerous nieces, nephews, and cousins.

John E. Silvray died on August 28, 1990. He was born in Youngstown, Ohio, in 1891. He studied courses in mechanical engineering and was employed by the Cold Metal Products Co. of Youngstown as chief draftsman and rose to chief engineer. John was a member of the Masonic Lodge and a Shriner, playing oboe and clarinet in the Shrine band. He liked to fish in Canada. One of his accomplishments was the building of a cottage of granite, including all home conveniences. He was married to Alice Kovch of Youngstown.

Otto C. Koppen died on January 20, 1991, on Cape Cod, Mass., at the age of 90. He was known as a pioneer in both airplane design and in the education of aeronautical engineers. As an instructor at MIT, his students included four future admirals and two future generals, among them General James H. Doolittle, who in 1942 led the first U.S. air raid against Japan. Professor Koppen enjoyed widespread recognition for his work on light, safe, and easy-to-fly airplanes, culminating in 1950 with his "helioplane," a short take-off and landing aircraft which needed 100 yards or less to take off and which could climb at 20 degrees and land at 28-35 miles an hour.

He was born in Brooklyn, N.Y., in 1900. After receiving an SB in general science, he worked for the National Advisory Committee on Aeronautics at Langley Field, Va., and for the Aviation Branch of the army Signal Corps at McCook Field, Ohio. From 1925 to 1928 he designed for Henry Ford. Professor Koppen returned to MIT in 1929. With the exception of World War II, he remained there until his retirement in 1965. In 1929 he married Eva de Wilde and they lived in Wellesley Hills, Mass. She died in 1973. He is survived by two children, six grandchildren and three great-grandchildren. What a wonderful contributor to aviation!

Our condolences to these families.—**F. O. Almquist,** secretary/treasurer, 63 Wells Farm Dr., Wethersfield, CT 06109

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The only news coming to me this issue was sad. A notice from **Delbert W. Kendall** told us of the passing of his wife, Erina, just two months after their 50th wedding anniversary, on February 19, 1991. All our sympathy goes out to you, Delbert. . . . Also, we have learned belatedly of the death four years ago of Esther N. Bone of Scituate, Mass., widow of classmate **Alexander J. Bone,** former associate professor at MIT.

With nothing else to say one talks about the weather, right? It has been raining in California. We are now going off rationing, but we will never have that same carefree attitude about water again.—Co-secretaries: **Katty Hereford,** No. 237, Box 5297, Carmel, CA 93921; Col. **I. Henry Stern,** 2840 S. Ocean, No. 514, Palm Beach, FL 33480

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Sam Spiker reports that while in Florida last winter he and Elinor spent some time in the Naples area. This enabled them to have a pleasant visit one afternoon with Marion and **Franklin Fricker.** The Frickers were moving in late March to 122 Mooring Park Dr., Apt. G-210, in Naples. On another day they took Eleanor and **Fred Greer** to an MIT luncheon held at the magnificent new Ritz Hotel North in Naples. In early June, Sam will be off to Pottstown, Pa., to observe his 70th reunion at the Hill School.

The passing of another classmate must be reported. **Lewis R. Collins** died on March 2, 1991, at a nursing home in Portland, Maine. He leaves his wife of 50 years, Mildred (Miller) Collins, a son, and a daughter. Lewis was employed by Guy Gannet Broadcasting Services from their first broadcast until he retired in 1969.—**F. Leroy (Doc) Foster,** secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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You know that I like to have classmates who are still doing things to write me about their activities. I haven't received any news at this time. I talked with three members and asked them to write to me, but none have to date. One of them, **Peter L. Belluschi** of Portland, Ore., known world-wide for his contributions to sending electricity around the world, was asked to write and solve a problem on TV, but he isn't feeling up to it. . . . Did any of you go to see Charles M. Vest inaugurated as the 15th President of MIT in May?

J. Fred Buenz of San Antonio, Tex., died March 8, 1991. He leaves his wife of nearly 60 years, Harriet, sons, daughters-in-law, and grandchildren. **Bob Dean** writes that he, Fred, other architectural students, and their teacher had lots of fun with graduate students. His eyes gave out in 1987, so he had to give up his work. . . . **F. Spaulding Dunbar** died April 14, 1991. He earned a naval architectural degree in the first Naval Aviation Program at MIT. He received his Navy wings and commission in the Navy Reserves in 1926. Spaulding had a very interesting life before he settled in Chatham, Mass., in 1932, when he established a boat yard. He leaves a son, two daughters, and five grand-children.—**Donald S. Cunningham,** secretary, Eventide, 215 Adams St., Quincy, MA 02169, (617) 328-1840

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Andrew Anderson, now living at the Wildwood retirement community in Ft. Lauderdale, has forwarded his autobiography typed in 1988. A 54-page double-spaced perfectly typed document, Andy presents the story of his life with such finite detail that he must have recorded it in diaries through the years. "Memoirs of a Manager" comprehends far more than its title suggests, tracing the lives of his grandparents and parents in Sweden. Having immigrated to Bridgeport in early 1900s, he was born in 1906. After obtaining his degree in electrical engineering at MIT, he joined Monroe Calculating Machine Co. in Orange, N.J., as cost engineer. In 1937, Mr. Monroe appointed Andy to plant manager. He met and married Anna in 1939 and took a grand European honeymoon, and later moved to a farm in remote Bernardville. Having joined the Army Ordnance Reserves earlier, he felt the urge to join the Ordnance District Office in downtown New York. He became captain and supervised the Inspection Division for Supplies and won the Legion of Merit Award for his good services. In late 1944, he was asked to join Thomas A. Edison Co. of West Orange as chief engineer and plant manager. After a brief term with M.H. Rhodes Co., he was asked to rejoin Monroe Co. as vice-president. He returned to Monroe, then a division of Litton Industries, at their Bristol, Va., plant and became vice-president.

Eventually he and Anna retired to Pompano Beach after long years of stressful work. Urged by his daughter, Jane, his document seems to typify many engineers' experiences in life, but who never took the time or had the patience to put on paper. He comments sadly on the lack of humor in the pragmatic character of an engineer's life, an essential ingredient to a balanced existence in this world.—**Joseph C. Burley,** secretary, 1 Harbourside Dr., Delray Beach, FL 33483; **Lawrence B. Grew,** assistant secretary, 21 Yowago Ave., Branford, CT 06405

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With due consideration of our age and infirmities, it is gratifying that members of our class are ready to think about our coming 65th Reunion as suggested in a recent letter from **George Palo,** our class agent. Your reunion committee will take all possible measures to abide by your needs and wishes in the coming months. In time we will summarize thoughts and conclusions, but so far your secretary has heard from **Hyman Weinberg** and **Roland Earle** in Florida and **Harlan Paige** in Connecticut. Ann and **George Palo** are visiting their old haunts in Tennessee for a month so responses to him will be reported later. But do contact one of us by phone or letter sometime, even if based on wishes rather than assurance of attending. . . . We have already had wonderful reunion participation by widows (who are officially members of the class as are spouses). **Florence Smith** has heard from Betty **(Chester) Day** that she is anxious to be informed of plans and intends to be there. Reunions are for all who have prior connections with them, who help uphold the numbers and excitement of the event.

Notes on reply stubs on MIT communications are welcome clues to activities. Miriam and **Clifford Terry** have been traveling in European and Middle East countries but apparently departed before the recent tensions erupted. . . . **Arthur Josephs** expresses a common opinion. . . . that merely being in the Class of '28 warrants a star for activity.

As can be expected, there are the inevitable notifications of deaths of classmates. **John Kiernan Rouleau** died on February 4, 1991, at Boynton Beach, Fla., where he has lived since retirement in 1967. He taught at MIT and other colleges, served in the U.S. Army, and later acted as science advisor to embassies and the Atomic Energy Commission. . . . **Augustus Rudolph Rogowski** died March 13, 1991, in Needham, Mass. A specialist in internal combustion engines, he had retires as professor emeritus and director of the Sloan Automotive Laboratory at MIT. Our condolences to Dr. Rouleau's family and Professor Rogowski's widow and family.

It is gratifying to hear that the **James Donovan** Scholarship Fund has this year been divided between two women chemical engineering students. Jim's good deeds, and those of all scholarship donors, will be long lasting.—**Ernest H. Knight,** secretary, Box 98, Raymond, ME 04071, (207) 655-4231

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Earl Erickson (wife Marian) from Burlingame, Calif., sent "congratulations on becoming a new member of the great-grandchildren club" and informs us, "We are doing very well, considering our 85 years of age and the usual health problems that go with it." . . . A note from **Hunter Rouse** (wife Doi) reads, "What's new with us? We spent the winter worrying about our older son, a professor of medieval history at UCLA, but presently doing historical research in Jerusalem. Our very best wishes to you both and all the classmates." . . . Prof. **John Happel** (wife Dorothy) of Hastings-on-Hudson, N.Y., writes, "You are lucky to have a great-great granddaughter. My children are much slower, so I don't know whether I am going to have one at all. Dottie and I keep so busy that we don't know where the time goes. She played the first plastic violin at Carnegie Hall. I have been busy at Columbia and CRC working on a new process for separating nitrogen from sub-grade natural gas. We both took a trip to Costa Rica with our young daughter, Ruth. Besides the animals and monkeys in the Monteverde Rain Forest, for me the most exciting thing was to fly over the world's most active volcano as it erupted. Recently, I had lunch with two MIT chemical engineers with whom I worked, H.S. Kelly, Jr., '41, and Lester Steffess, '30. . . . A note from **Chung Foy Yee** (wife Zai Chen) of Worcester, Mass., includes his best wishes to all classmates.

I regret to announce the death of Prof. **Otto Edward Wolff** of Weston, Mass., on March 9, 1991. He lived in Weston for many years. He attended New York University, was a 1927 graduate of Colgate University, and received a master of science degree in aeronautical engineering from MIT in

1929. He taught at MIT and later joined the Land Wheelright Laboratories in 1937 which later became Polaroid, retiring in 1982. He served as a key witness in the landmark Polaroid-Kodak trial. He was an inventor, holding a number of patents including a disc brake for airplanes. He was a former oarsman for both Colgate and MIT crews. He was also an active member of the Cambridge Boat Club and the Community Rowing Club. He is survived by his wife of 50 years, Doris Connelly, two daughters, a son and a granddaughter.—**Karnig S. Dinjian,** secretary, P.O. Box 83, Arlington, MA 02174, (617) 643-8364

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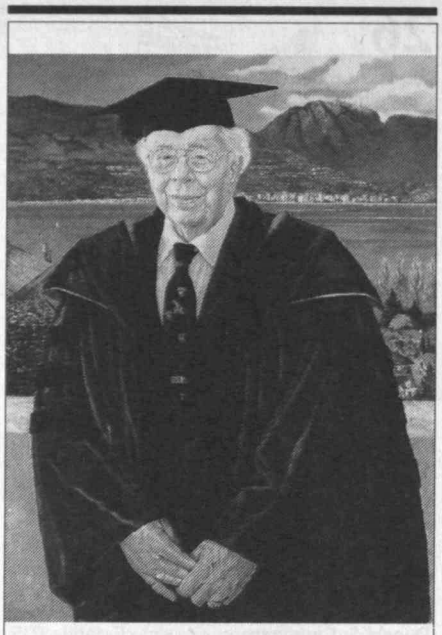
It is only rarely that the secretary of a class that has had its 60th reunion has an opportunity to report a classmate's marriage, but this month is such an occasion. Last December 29, **Alfred Luery** and Maxine MacFarlane were married in Seminole, Fla. Al met Maxine while she was visiting her daughter in Florida last October, and they "were immediately attracted to each other." Maxine comes from Oregon, and as of April 1991 they were planning a trip back to that area. Best wishes to our newest newlyweds.

Those who returned for our 60th reunion will recall that **Joe Kania** came east from Vancouver, B.C., and attended the reunion with his daughter, Patricia Clunis. In his latest report, Joe notes that he has been on 27 world trade missions for the Vancouver Board of Trade and has visited 61 different countries. As previously reported, Joe received an undergraduate degree from the University of British Columbia and a doctorate from MIT in 1930. His photograph, taken on his 90th birthday attired in the cap and gown he wore when he received his MIT degree, appears elsewhere on this page.

Lester Steffens plans for the summer of 1991 include six weeks of "volunteer handy-manning" at the Wyoming Audubon Camp and six weeks enjoying "Yosemite, Utah Canyonlands, and Colorado scenery." Les also does volunteer teaching at a "one-year-old private high school for kids who want an education." . . . A bit more than two years ago, **Irving Dow** moved to a new life-care community in Mitchellville, Md., where he keeps busy as a member of the Fiscal Review Committee. . . . From Tempe, Ariz., **George Perry** writes that he and his wife have lived for the past five years in a retirement community of about 700 people. He notes that the many years they lived close to the equator conditioned them to endure the hot summers of southern Arizona. George's activities include stargazing through his telescope, "plunking out oldies" on his guitar, and reading.

Adolph Hugin notes that he was one of seven members of the class who participated in the MIT and G.E. work program that led to an SM in electrical engineering in 1930. Of this group there are five other survivors: **Levin Foster, Alfred Ennis, Maurice Jones, Vernet Kauffman,** and **John Mathews.** Adolph's career as an engineer, teacher inventor, and lawyer, as well as his work with many civic, social, and religious groups have been previously reported. He now lives in North Springfield, Va. . . . **Tom MacLaren** worked for Brown & Sharpe, machine tool manufacturers, for 45 years before retiring as their general sales manager. He notes that he had the good fotrune to represent them in a variety of locations—five years in Philadelphia, four years in Los Angeles, four years in Chicago, and two years in Sweden, Denmark, and Poland. Tom and his wife Hope live in North Kingstown, R.I. . . . **John Scheuren** writes that daughter Margot recently presented him and Maggie with their eighth grandson, who is also their twelfth grandchild.

Since the July notes were written we have received notices concerning the deaths of three more classmates. One long-delayed report from **Allen Prescott**'s attorney indicates that he died sometime in 1983. . . . Also, **George Williams'** wife has reported that he died September 5, 1990. Unfortunately I do not have anything in my records about either of these men. . . . The third notice reports the death of **Louise Dingwell** on March 17, 1991. Louise received an undergraduate degree from Wheaton in 1924, did graduate work in the field of hospital administration at Johns Hopkins in 1925, and studied public health administration in Course VII at MIT in the late 1930s. She attended a number of our class reunions and had a varied career. During World War II she worked on the Manhattan Project in Hanford, Wash. For a time, she was assistant to the dean of the Katie Gibbs School in Boston and later became a real estate agent in Little Compton, R.I. She was active in both the Society of *Mayflower* descendants and in the DAR. She is survived by a niece, Lydia Wheeler, and a nephew, Paul Dingwell.—**Gordon K. Lister,** secretary, 294-B Heritage Village, Southbury, CT 06488



This portrait of Joe Kania, '30, in his 1930 MIT Doctorate robes was painted by a family friend on the occassion of his 90th birthday. He stands on the terrace of his former Spanish hacienda which he designed and had built in 1936 and lived in until 1988, overlooking English Bay in Vancouver, Canada.

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Please send news for this column to: **Wyman P. Boynton,** secretary, 668 Middle St., Portsmouth, NH 03801

32

60th Reunion

Tom Weston, our reunion chairman, has unexpectedly run into serious health problems. He had a heart attack and bypass surgery. After some time in Braintree Rehabilitation Center, he is now at home slowly gaining his strength back. His voice over the phone is strong and his manner upbeat as usual. For our 60th Reunion for 1992, Tom will be the honorary chairman. **John Brown** and I will take on the duties of chairman.

On April 30 **John Brown** and I attended an MIT Alumni/ae Association dinner meeting labelled, "Reunions 1992-Kick Off Meeting." Many of the staff and professors spoke to us and stressed how important the endowments and contributions are to MIT's success as an institution. Incidentally, there are 234 active alumni in the class of 1932. The Alumni/ae Association predicts that 33 of us will attend the 60th with 17 guests. I think we will do better. Perhaps this is a good time to call your attention to the fact that MIT has an In Memorium Fund. It is possible to honor a departed classmate by giving a gift to this fund and at the same time help MIT to further its service to society through its educational and research programs.

Our classmates who already have been so honored are: **Sidney G. Albert, John A. Finnerty, Allan M. Maguire, Harold A. Traver, Walter C. Voss, Carroll L. Wilson,** and **Henry E. Worcester, Jr.**

There is a great deal of ferment going on in this country about education. For us to be globally competitive we must improve our math and science programs in our schools. Our classmate **Charles Spiegal,** writes that he is deep into math/science education and getting in deeper every day. He notes that MIT has been a leader in technical education and training. He appeals to his classmates who have time and want to do something about education in this "Decade of Decision," to write or call him at 200 Via Alameda, Redonda Beach, CA 90277, (213) 378-3748.

Keep writing. Send pictures.—**Melvin Castleman,** secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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We apologize to **Harry Steinman** of 2633 Singing Woods Dr., Hillsboro, OR 97123, for printing notice of his death in the May/June classnotes. He is still alive, happily, and we regret any harm this may have caused.—ed.

Please send news for this column to: **William B. Klee,** secretary, Box 7725, Hilton Head Island, SC 29938, (803) 785-7746

34

I'm sorry I've lagged so on notes in recent issues—a bug laid me up so the material for the May-June issue was so late getting to Cambridge that it couldn't make the issue. You've now seen it in the July magazine.

As a result, information on losses has accumulated. Going back chronologically, I have a word of the passing of **W. Arthur Smith** on October 26, 1990, at Tenants Harbor, Me. He was a mechanical and textile engineer and had specialized in the design and development of anti-friction bearings and pioneered intricate combinations of precision gears with ball and roller bearings. He served as a consulting engineer to MIT and the U.S. Air Force in analyzing the rotation of large masses. Mr. Smith's professional relations were many: a member of the National Society of Professional Engineers, a life member of the ASME and former chairman of its textile engineering division, and the recipient of a citation from ASME for his advancement of mechanical engineering. He was a veteran pilot with multiple civilian ratings and a life member of the Ancient Order and Secret Order of Quiet Bird Men. He is survived by his wife Jane, two daughters, two grandchildren, and a sister.

From both MIT and our classmate Maurice Marshall I received information about the death of **Paul Grueter,** in Milton, Mass., after a long illness. He had served in the Army Corps of Engineers in World War II, commanding Camp Rodman in New Bedford, Mass. He supervised the construction of several dams and helped establish Limestone Air Base in Maine. He retired from Federal service in 1973 and then worked for Fay, Spofford, and Thorndyke in Boston until

1979. In this latter position he designed and supervised much of the Wareham sewage treatment plant. He was an enthusiastic photographer and produced many slides of places he visited, both for work and pleasure. At MIT he had been a member of the Glee Club and had rowed with the crew. Paul's wife died in May 1990 but he is survived by a son, two daughters, six grandchildren, a brother, and two sisters.

On January 3, 1991, **Ewald H. Andresen** died in Pennside, Pa. He had majored in building engineering and construction and was general superintendent for Turner Construction Co., N.Y., for 25 years, retiring in 1976. Surviving are his wife Kathleen, a son, two daughters, and eight grandchildren.

Finally, we learn through his sister, Margaret Chew King, of the death, in January, 1990, of **Lun Kee Chew** in El Paso, Tex. Her information came with a memorial check to the Alumni Fund, a most thoughtful gift.

To these families I would extend sympathy on behalf of the entire class.

I have one stray Alumni/ae Fund note from **William Milliken, Jr.,** who is living in Williamsville, N.Y. He says, "I am president of my own R&D company—Milliken Research Associates, Inc. We do R&D in areas of car S&C (?), tire mechanics, car aerodynamics. My son, an MIT grad is vice-president."

John Hrones, who is currently president of the MIT Club of Southwest Florida, has been valiant in his efforts to provide material for these notes. He wrote lately about some recent contacts. John says, "I dropped in for a brief visit with Charlotte and **King Crosby.** They live at Pelican Cove, a lovely secluded spot. King is recovering from several operations required to clear blockages in the two arteries supplying the head. He is making good strides to full recovery but still has a way to go. Charlotte looks great. They will be back on the Cape as usual for the summer; this time in a condo in Centerville. They have done considerable traveling and we recalled a trip that the Crosbys and Peg and I took together some years ago."

John continues, "At an April 7 MIT gathering on Casey Key, Sarasota, I met Wendy and **Wallie Bird.** Wallie married Wendy nine years ago. They have recently moved to a retirement community adjacent to Pelican Cove. Wallie has retired and sold his ownership of BirdAir. He had built the company from scratch—as you may know, they are air-supported structures. They were designed originally for the armed services and went on to house indoor sporting events. The indoor tennis courts at MIT and the Sun Dome in Miami are typical examples of fabric covered arenas and playing fields built by BirdAir.

This is the last chance I'll have to plug the mini-reunion that is in the works for Canada at the end of September. In case you missed the information in earlier notes, we're planning to go to the Chateau Montebelle, one of the very spectacular hotels in Canada, located midway between Montreal and Ottawa. We will be chartering a bus from Boston that will leave here Tuesday morning, September 24, will take us into Ottawa on Thursday for a visit to Canada's capitol, and return to Boston on Friday, the 27th. The hotel will cost roughly $228 per day per couple, MAP, and we estimate the bus cost at about $250 per couple. To help keep the overall costs down, there will not be any general mailing for this event. So if you are interested, write **Carl Wilson,** reunion chairman, 48 Druid Hill Road, Newton, MA 02161 (617) 527-7088, or our treasurer, **Laurence Stein,** 374 East St., Hingham, MA 02043.

I'm finally getting back to travelling again. We're leaving in two days for about two weeks in California. The immediate excuse is the 10th anniversary of the California State Railway Museum in Sacramento, plus the fact that my wife has never been west. Please don't sneer at my "excuse"—Gerry and **Larry Stein** are going to Hawaii in July to see the total eclipse that is happening then.—**Robert M. Franklin,** secretary, P.O. Box 1147, Brewster, MA 02631; **George G. Bull,** assistant secretary, 4901 N. Park Ave., #711, Chevy Chase, MD 20815

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I just had a long telephone chat with **Chester Bond,** who lives about 60 miles north of Escondido in Sun City. Chet has been home only a few days after five months in and out of the Norris Cancer Center, where he had two surgical procedures. His problems apparently started in early December, when he had to have a quadruple bypass open heart surgery. His years in Florida's and southern California's sun caused cancer on his head. Then cancer was also discovered in his throat. He is pretty low on energy at this point, so much so that he considers a cloudy day as his kind of day. We both use #30 sun screen liberally. Chet's oldest son Christopher used to be in the CB's in Vietnam and has used that experience to become building superintendent in hospital construction. His son Tony is a Johns Hopkins graduate and works with a large law firm in Washington, D.C. Daughter Rosemary still lives in Swampscott, Mass., where Chet and I grew up. I am sure Chet would enjoy hearing from his old friends. Call him at (714) 679-2738 and his wife Dorothy will probably answer.

I also talked briefly with Sidney Grazi who lives in Carlsbad, Calif. For the past seven years, Sid has been on the board of the Roundtree Homeowners Association as VP. His friends decided that since he was doing all the work, he might as well be president, so that is what he was involved with when I called him. He said he had seen **Irving Banquer** and his wife, who spend about six months a year in the Hillcrest area of San Diego, "right in the flight path," according to Sid. He said he had also seen **Mortimer Rosenbaum** and his wife, who are San Diego residents.

I guess I'm the only one who is still playing golf on a regular once-a-week basis. Being single and living in a small apartment makes a big difference.

Thirza Morrow, widow of **Thomas F. Morrow,** died in Grosse Pointe, Mich., on March 11, 1991. Tom died prior to our 50th reunion in 1982. He was a member of the MIT Corporation.

Now, how about those letters? Write to—**Allan Q. Mowatt,** secretary, 715 N. Broadway #257, Escondido, CA 92025, or call me and leave a message at (619) 432-6446

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It's April 26 and I have just returned from a trip to San Francisco and a very successful round of visits. There is so much to report that it will take a few issues to cover the ground. For this issue I will list the Bay Area visitees in order of calling: **Art Jaegar, Boris Maximoff, Franklin Cooper** (telephone), **Luis Emilio, Robert Tripp, Bill Hewlett** (telephone and videotape), **Ransom Pierce, Jim Seth, Emanuel Rappoport, John Myers, Fred Myer, Al Horton,** and by mail and telephone, **Bernard Gordon.**

Some of you may remember the account of four substitute crewmen rowing *across* the Hudson River to New Jersey in the spring of 1934 (Feb./March '88 issue), with **"Shorty" Hubbard** bailing with his hat to keep us afloat. From **Art Jaeger** (Course X) I learned now that he was in the group of eight rowing against Columbia on the Harlem that day. The following year **Art, "Slim" Beckwith, Art Dolben,** and myself were together in the boat, and are pictured on page 157 of the 1936 *Technique.* Art started his career with RCA in New Jersey, using his chemical training to make ink binders for labelling glass radio and video tubes. Soon he was into tube components and electrical engineering (who knows where frosh-soph training in everything will lead?). As companies in this volatile field prospered, failed, or were absorbed, he moved to National Union Electric, Sylvania, Varian, EMAC, and Teledyne, always in demand and by invitation. Art recalled **Charlie Endweiss** when he was a flying cadet at Squantum and **Bill Benson** who was killed in a 1940 air accident while a naval flight engineer at Moffett Field.

Boris Maximoff (Course VI-A), born in Russia near the Estonian border and raised there through a few years of grade school, in 1990 translated papers on political economics for Stanford University. In 1977 Lockheed sent him to the USSR for demonstrations of the L1011, but there was no sale. The Russians were after ideas, not hardware. Boris' wife, also Russian born, broadcast in Russian for BBC from London, and they met during World War II. Air support of ground troops was hardly off the ground then, and Boris devised an adaptation of the instrument landing system which worked with a minimum of casualties of "friendly fire," and was used for the rest of the war. Boris won the Bronze Star for this and for a telescoping antenna for life rafts which saved the lives of air crews unable to make it back across the Channel, or elsewhere on the seven seas. This electrical engineer got into the fringes of Course XVI stuff (at United Aircraft reducing propeller vibrations, and also work for Aero Electric and ITEK) and made his mark.

Franklin Cooper, who majored in physics is retired president and research director of Haskins Laboratories in New York and New Haven, now living in Palo Alto. When I called in advance of my trip I learned that his wife had died a few weeks before and he welcomed my forthcoming visit. In the meantime, however, he contracted double pneumonia and could barely speak on the telephone. We promised to visit by wire in a few weeks. . . . **Luis Emilio** (Course II) mixed engineering (United Shoe, Ryan Aeronautical) with farming, from graduation to early retirement in 1963. While with Shoe he had a dairy and poultry farm in New Hampshire, but he tired of weather conditions which ate up farm revenues. So he scouted southern regions of the country and landed with Ryan as manager of contract estimating, and bought 65 acres in the San Joaquin valley 400 miles from San Diego, plus a poultry ranch nearer by. Busy weekends but good production, including walnuts from an orchard he planted. **Wilbur Oliver** (Course II), who operated a resort in the Santa Cruz Mountains until 1981, visited the orchard, and kept in touch after moving to Florida, until his death of a brain tumor (January '91 Notes). Luis also recalled **Ron Beckman** and **George Moustakis** fellow owners of a 56-foot ketch, which they sailed off the New England coast. Luis sold the walnut farm in 1980 after a heart attack, but is in general good health. He and wife Delores spend the winters at their second home in Arizona.

Robert Tripp (Brig. General Ret'd) joined our class in Course I as a graduate student from West Point, laying the groundwork for assignments as instructor and (after World War II) associate professor of physics. During the war as transportation officer he helped in the planning of Operation Overlord, and landed at Omaha Beach on D-Day plus three to follow the ground troops with supplies through Normandy. In the 1950s he was at SHAEF headquarters in Paris in between assignments in Washington, and finished active service in 1958-63 as commanding general of Pacific Terminal Command at Fort Mason. As a civilian with much Army port experience Bob helped plan a facility in Okinawa to receive California exports of rice, and solved a bottleneck of shipping in Camranh Bay, Viet Nam. He retired in 1978 after ten years as vice-president of Acme Dunnage Co., which separates, blocks, and braces freight to insure that it and the ship get where they are going. Bob was a widower at this time and remarried. On the mantle of their home in Oakland sits an MIT clock, inscribed Brig. Gen. Robert C. Tripp Class of 1936 to Lyliane Christmas 1989.

In March, a call from **Al Musschoot** (Course II) about the upcoming (then) reunion gave an opportunity to update his 50th biography. He is still fully active as CEO of General Kinematics Corp., which he founded in 1960. They manufacture heavy duty vibrating and compacting equipment in Illinois and England, and, with licensees in Australia and New Zealand, supply processors, conveyors, etc. throughout the world. Some of their custom made products vibrate garbage for incinerators and compact the ashes therefrom. I shall think of him the next time my dentist uses a compacter on a new filling.

A clipping forwarded by **Pat Patterson** datelined Boston reports **Bob Gillette's** appointment by the Federal Housing Finance Board to be chairman of the Federal Home Loan Bank of Boston. This is an $11 billion central bank for 311 member mortgage lending institutions in New England. Congratulations, Bob! . . . **Bill (Slim) Beckwith** and Dinny were at the annual San Diego Crew Classic the first week in April, and sent a batch of newspaper articles and pictures (Harvard won the varsity race, beating University of Washington by more than two lengths, and Boston University won the women's event). Slim says he felt the urge to get back in a shell again, and feels fit as a fiddle despite some recent surgery. "Can we get four or eight oarsmen together for a last hurrah on the Charles?" Yessirree!—**Frank L. Phillips,** secretary, 1105 Calle Catalina, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson,** assistant secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

37 55th Reunion

Paul Allen was executive vice-president for Cyprus Mines, and is now semi-retired and continues as a mining consultant. He is an enthusiastic mountain climber and cross-country skier. On January 26, 1991, he returned from climbing Mt. Vinson (16,000 feet) in Antarctica, and on April 1 went on a two-week ski trip to Spitsbergen, Norway. He is not sure what he will be doing in June 1992, but hopes to make our 55th reunion. Paul and his wife Marjorie live at 1175 Glen Ave. Blvd., Pasadena, CA 91105. . . . **Bob Glancy** writes "Daughter Col. Carol Glancy married Col. David Huss in March. My wife Carrie suffered a second heart attack in June 1990 and a third in December. We are in the process of finding a nursing home. Son now unemployed for 15 months with a family of four. Young daughter Sharon and husband, Dale Phillips, now run Hi Mountain Diesel Co. in Brodheadsville, Pa."

Sidney Mank is still involved in community activities, Lions, literacy (tutoring dropouts for their GED equivalents), and gardening. . . . **Ray McFee** has retired from McDonnell Douglas but continues as a consultant in their space systems. He has received awards in the field of solar-power optics. Ray's main interests are in choral singing (church choir) and in fine-furniture making for his family. He mentions that he greatly enjoyed the 50th reunion and plans to attend the 55th.

Duane O. Wood writes from 920 Linda Flora Dr., Los Angeles, CA 90049, "After reading the April *Tech Review* class notes I was inspired to send a few items to contribute to the news. I went to Cambridge in December and participated in one of the MIT Alumni Campus Visiting programs conducted by Professor Philip Khoury. It was very well planned and executed, and I was very impressed at the great progress our alma mater is making in the educational field. While I was there I drove up to Concord, N.H., and had a great visit with Louise and **Bill Wold,** whom I had not seen since the last time they were in California. After that I went to London on a business trip. Although I am twice retired I try to keep busy, and I am actively working on some Middle East projects, mostly in Turkey. Also, I keep active contacts with my former Lockheed colleagues, and we have been congratulating ourselves on the success of many of our high-tech products in the Gulf War, some of which were started while I was with Lockheed, particularly the F117 stealth fighter."

Ed Herbig retired in 1965 from E.F. Johnson Co. Ed states, "My main interests today are primarily local politics. In our small town (population 1,770) we have a very confused situation, and I am working with other public-spirited people to see if we can improve matters. It is amazing how, in such a small town, we can generate so many problems." Ed and his wife Elaine live at 225 S. Buchannon St., Waterville, MN 56096. . . . **Harry Corman** is a self-employed, semi-retired structural engineer. "I work at keeping our retirement house in good shape so that all the family and friends will come visit to ski and enjoy the Vermont life. The self-employment is a few hours per week to keep in touch with the local architects and engineers." Harry shares an airplane with his brother and flies around New England, but no more long trips. Harry and his wife June live at 1416 Crossett Hill Rd., Duxbury, VT 05676. . . . **Joe Keithley** has retired as chair of the board of Keithley Instruments of Solon, Ohio. Welcome to an over-growing class of '37 group of retirees.

I regret to report the death of **Leo Rosen** on March 16, 1991. He was a cryptologer with the Army Security Agency, served in the Army during World War II, and was awarded the Legion of Merit. He retired in 1967 from the National Security Agency, where he was assistant director for research and engineering. At his retirement he was awarded the agency's Exceptional Civilian Service Award. His marriage to the former Elizabeth Wrenn ended in divorce, and his second wife, the former Rose Kidney, died in 1976. Survivors include two sons from his first marriage and four grandchildren. . . . Following a brief illness, **Harry W. Kohl** passed away on February 1, 1991. Harry was a member of the MIT varsity crew. Our condolences go to his wife Edna, who lives at 1847 S. Eastview Dr., Camano Island, Washington 98272.

Our class is responding well to our request for news for our class notes. As much as you enjoy hearing about your classmates, please know that your classmates look forward to getting up-to-date news about you. Keep up the good work—we look forward to hearing from you!—**Robert H. Thorson,** secretary, 66 Swan Rd., Winchester, MA 01890

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Since last year **John Petroskas,** who retired in 1977 as chief metallurgist for Phoenix Steel Corp., traveled to Maui and Kauai. Following horrendous weather and a cold, he returned to the mountains. Hopes to get to Barbados this year. . . . Jean and **Ed** (our assistant secretary) **Hadley** will be gone most of the month of May on a trip to Morocco, Spain, and Portugal—arriving back just in time for our mini-reunion at Endicott House.

You may remember that in his will **Peter DeFlorez** endowed a full professorship and in addition established a $500,000 fund for the promotion of humor at MIT. It has already underwritten the publication of a book on pranks at MIT. The local press recently reported that Gary Isaacs, '79 (SB and SM in mechanical engineering), returned to the Institute to deliver the inaugural DeFlorez lecture. Last year Isaacs, a former West Coast space engineer turned Wall Streeter, was one of 39 out of 2,000 applicants accepted for Ringling Bros. and Barnum & Bailey Clown College, where he earned an MFA—Master of Fun Arts. He delivered his DeFlorez lecture in his best suit—a baggy three-piece one with riotously clashing red-and-green stripes to go with his strawberry-blond wig and floppy green shoes. Doesn't that sound just like the MIT of the 1930s! Peter, an inveterate prankster himself, would have been pleased. More later. If the *Review* doesn't report on it, Ed and I will in the next issue.

Arnold Kaulakis sent our president **Horace Homer,** a crackerjack of an article about an Ivy League class secretary who became so frustrated by lack of news from his classmates that for six years he reported a series of the most outlandish episodes of a nonexistent classmate. Please don't make Ed and I start writing fiction. Let's hear from you! We know you travel, have new hobbies, are active in your communities, and occasionally see other classmates.

We must again close on a sad note and report that **Hubbard Little** passed away last October. Hubbard had to leave MIT after two years to take over the Universal Drafting Machine Co. upon the death of his father. Under his leadership the company produced many innovations. Among other improvements he developed a method in the 1950s for linking a computer to their drafting machines—which doubled the amount of work draftsmen could produce. In 1973 the company was sold to the Dietzgen Corp., and Hubbard then founded Analex Computing, Inc. He continued to do consulting work until two weeks before he died.—**Don Severance,** secretary, 39 Hampshire Rd., Wellesley, MA 02181; **Ed Hadley,** assistant secretary, 50 Spofford Rd., Boxford, MA 01921

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Harold Hindman founded Instron Co. in 1945 to manufacture and market instruments and systems to assess physical properties of materials and structures. His company went public in 1962 and expanded to have 1,064 employees on three continents. Harold delegated his presidential duties and finds his current activities as chairman of the board allow him more time to enjoy four children and 12 grandchildren. . . . **Elihu Root** reports from Clinton, N.Y., that his hobby is computer hacking. He started this hobby before 1977 with a "KIM" computer the memory of which was limited to one K! Elihu was one of the pioneer programmers who used only "machine language"! . . . **Bill Pulver** and Adie, returning from Mexico, visited Don Weir, '38, and Betts, Wellesley '39, in Beverly Hills, Calif. . . . **John Herlihy,** in retirement after a career with Inland Steel, enjoys arranging biannual reunions of World War II veterans of the 110th Bomb Group usually attended by as many as 1,000. During World War II John's activities included maintaining B17 bombers based in England, France, and later in Germany.

Fred Grant, chairman of our coming 55th Class Reunion, reports **George Beesley** and **Paul Stanton** are forming a questionnaire for classmates to vote where and when each prefers to hold the informal part of our 55th Reunion. We can help by replying promptly.

Phil Bush and Margie vacationed in Mazatlan, Mexico. They found the food excellent, but did not report whether they fished for marlin or swordfish.

Norm Klivens, '40, chairman of 1940 Class Mini-Reunion to be held January 4-7, 1993, at Naples, Fla., invites '39ers and '41ers to attend. I sent Norm a list of '39ers who reside in Florida and recommended each be asked to express his desire to (1) attend, and (2) be chairman of the '39 contingent.

Art Zeldin and Helen moved to Silver Springs, Md., joining **Ernie Kaswell** and Yolande and **Seymour Sheinkopf** and Sylvia to increase the cadre of 39ers in the vicinity for mini-reunions. Seymour says they have already organized a round-robin luncheon schedule. Seymour and Sylvia expect to attend the investiture of President Vest in Cambridge and visit special friends including **Aaron White** and Edie and **Mike Norman** and Grace.

The Jim and Nancy mix-up in the May/June issue of the Class Notes raised a few questions. Were the questions to have been cast in the form of radio soap opera advertising teasers about

events to come, one suggests typical cliff-hangers might have been: "What will Mary (Barton) say when her lady friends phone to ask 'Is it really true that kind, gentle, thoughtful Jim toured a cave with Nancy?'" or: "What will Jim (Barton) say when a hundred of his constituents phone to ask 'After the absolutely perfect lawn party celebrating your's and Mary's 50th Wedding Anniversary how do you square taking Nancy off to tour that cave?'" Or, for the Alexanders who also have celebrated the 50th anniversary of their wedding: "How will Nancy (Alexander) convince callers she never was in a cave with Jim (Barton)?" Or: "What will John (Alexander) say except 'Nancy was with me all the time and you better ask the *Technology Review* where it got its information!" The missing clue to this fun spoof is: somewhere between Gig Harbor and the Concord printer, two-sentences suffered loss of 11 words from their middle. Here is how the unexpurgated copy was to have appeared: "Jim Barton and Mary are vacationing during February in Maui, Hawaii. . . . **John Alexander** and Nancy completed a tour to and through the Carlsbad Caverns of New Mexico."

We are saddened by news of deaths of two classmates: **John Cushnie** died February 14, 1991, in Philadelphia. There were no details. . . . An obituary in the *Boston Globe* reports **Eli Dannenberg** died April 23 1991, at his home in Longboat Key, Fla. He had been a former vice-president and scientific director of the Cabot Corp. of Boston, a specialist in the rubber industry. Mr. Dannenberg earned a doctorate in physical sciences at the University Louis Pasteur of Strasburg, France, in 1973. More information about his career appeared in our Nov./Dec. class notes.—**Hal Seykota,** secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

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Recently, I received an inquiry from Jack Michell of the class of 1941 asking the whereabouts of **Margaret Dienes.** She responded to me, with thanks, and to say she is fine.

Class president **Norman Klivans** reported further on the mini-reunion, tentatively planned for January 4-7, 1993, in Naples, Fla. He has contacted presidents of the classes of '39 and '41, with the hope that they may join us. This is a preliminary notice, to be followed with the mailing at a later date.

The organizing committee includes **Phil Stoddard, Doug Eckhardt, Spec Card,** and **Norm Klivans.** Arrangements have been made at a typical grand old Florida resort hotel complete with golf, tennis, card rooms, sand beach, wicker furniture, bars, and a lovely dining room. The Naples Beach Hotel and Golf Course has set aside rooms at a very special (tentative) group rate of $130/night for a standard room and $160 for deluxe rooms. (Remember, this is two years from now!) Other less expensive hotel or motel rooms are available nearby. Naples offers many attractions including fishing, boating, shopping, historic points of interest, and is just a great place to visit.

Invitations are being extended to the classes of 1939 and 1941. If enough alumni, spouses, and friends attend, we're trying for Charles Vest or Paul Gray to join us. Please show your interest by writing to Norm Klivans, 3123 Bremerton Rd., Cleveland, OH 44124, or to me. Do it soon. Tell us that you're interested. Give us comments about how you would like the program put together; whether the proposed accomodations are okay, etc. Unless we have positive indications from at least 30 of our classmates, we'll have to rethink the whole idea. So, if you want to have a good time with some of your classmates, spouses, and friends in Naples during early January 1993, write us TODAY.—**Richard E. Gladstone,** secretary, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

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Gilman B. Andrews writes, "I'm retiring for the second time. For over five years I have been managing the Power Electronics Group at Caltech. It has been a most fascinating, rewarding effort. I shall never forget the friends I made there, especially the students."

Calvin D. MacCracken writes, "Saw your suggestion re: who remains athletic in the class of '41. I graduated from MIT in 1941, after graduating from Princeton in science in 1940. In my one year at MIT, I learned from coach Jack Summers (national pro champion) how to play squash well. I have now won 11 national squash titles, the latest the National over 70 Championship, held in Rochester, N.Y., last year.

"I have been an inventor all my life, have over 85 patents, and was inducted in the New Jersey Inventors Hall of Fame in 1989. I founded my company, Calmac Manufacturing Corp., in 1947 with help from the American Research and Development Corp. of Boston, the first venture capital firm. After bumps along the road, my company is now doing well. Our principal product is Off Peak Airconditioning by Ice Storage to reduce airconditioning costs and shift utility loads away from their peak loads." Cal also won the Eastern over 60 and over 65 tennis championships, and will go after the over 70 championship this year. . . . The class of '41 has some very athletic members left. If you are one of them, drop a line to your secretary, and do a little bragging—golf stories, glider flying, and as is obvious from your questionnaires, bicycling.

Laurence Charles Turnock, Jr.—Track Club at MIT (chemical engineering), wearer of the "T", cross country, and gym. Larry runs six mornings a week, exercises, and plays golf three to four times a week, weather permitting. He is active in five civic organizations and lives in a condo in Chagrin Falls, Ohio, one of the most beautiful spots on earth. His wife of 47 years broke her lower right leg in a freak fall last year. . . . **Philip S. Lewis, Jr.,** is not quite so athletic. During the 45th reunion he suffered an angina attack. It was a warning. After a bypass operation he is now feeling fine, but is forced to take it easy. Phil wrote to **Ivor Collins,** our permanent money man, and I am passing it on.—**Joseph E. Dietzgen,** secretary, P.O. Box 790, Cotuit, MA 02635

42 50th Reunion

I am writing this in mid-April so Jean and I are just packing here in Clearwater for the trek back up North. The packing and trekking are a small price for a pleasant winter in Florida's sunshine affording nice tans and year-round golf.

Have visited with Hazel and **Fred Gander** and Audree and **John Altekruse** who winter just north of here in Dunedin. Also Francine and **Jim Stern** visited earlier in the season. Saw Joan and Dick Knight, '47, several times. Dick was secretary of the Alumni/ae Association for many years.

Herman Lorence has retired and moved to Oregon where his time "is spent keeping up an old house and two cars plus traveling in his motor home, sailing, chess, music, and fighting gophers." He does sound very busy!

You have all received **Jack Sheetz'** March letter and the form to complete for our 50th Reunion Yearbook. If you have not yet returned the questionnaire to Jack, DO IT TODAY! He's working hard on a really first-class book and the least we can do is to cooperate with him.

A pretty good month, only two obits: **Russ Thompson** in Baton Rouge, La.; and **Lee Freeman** in Newton Highlands, Mass. Our most sincere condolences to their families.

Let's hear from you all. It makes the Class Notes more interesting for you and easier for me to write!—**Ken Rosett,** secretary, 191 Albemarle Rd., White Plains, NY 10605

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Thaddeus J. Pieczonka passed away last October 23 in Lackawanna, N.Y. He was a principal of Pieczonka Consultants there. We extend our condolences to his wife Helen.

The National Academy of Engineering has a new member, **Frank A. McClintock,** elected in March. Frank is a professor in MIT's Department of Mechanical Engineering. His citation reads: "For pioneering and sustained contribution to the understanding of the process of ductile fracture of engineering materials."

From a conversation with president **Jim McDonough** I learned that **Bailey Nieder,** shortly after graduating in Course VIA, attended a brewmasters school in Portland, Ore. As a long-delayed result, he is now part of a retired executives program, starting up a brewery in Guatemala. Bailey nominally resides in Seattle.

Please remember the 50th Reunion, the Reunion Gift effort, and your secretary's need for news items, not necessarily in that order.—**Bob Rorschach,** secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Jane and **Lou Demarkles** hosted a meeting of a group thinking about a mini-reunion in October of this year. Present were Anita and **Les Brindis,** Jane and **Bob Barnaby,** Ruth and **Norm Sebell,** and **Stan Warshaw.** Charleston, S.C., is to be the locale and October 17-21 the dates. Plans should be well under way by the time you read this.

We had an interesting letter from **Burt Bromfield,** who had noticed on FNN (Financial News Network) that one of the leaders in the options contest was **Justin Margolskee.** The contest is run in real time and the object is to run a fictional $500,000 as high as possible. The winner gets a real $25,000 prize. At the time, Justin had run his money up to $3 million. Burt suggests that maybe the class ought to put together some money and let Justin play for real, with the benefits going to MIT.

Bobbie and Burt are pretty well retired. The Boston interests have been sold, the Florida business was sold in 1987, and they have been attending Elderhostels. In October 1990, they were in a program in Kathmandu, Nepal, and this February they were at Woods Hole Oceanographic Institute studying lobsters. Although **Jim Mayor** is retired from Woods Hole, he was one of the lecturers. Jim is devoting his time to archaeology. Burt also writes that he believes that **Doug Banus** has recently completed a trip around the world. Doug's annual letter was written from a freighter going north along the coast of Chile.

Sten Hammarstrom retired from C.F. Braun in November 1990. He is selling process and environmental analyzers part time. . . . After 19 years, **John Barmey** retired from the General Accounting Office in September 1990. He has returned under contract to conduct engineering systems analyses comparing fixed wing, rotary wing, and artillery missiles for close support in tactical warfare.

Al Picardi writes from the Virginia Eastern Shore that he thinks that South Carolina is a good mini-reunion location. He and **Ed Eaton** are working hard on the 50th-year gift and are interested in any ideas the class may have on increasing participation above the usual 55 percent level. . . . Ed writes that after 41 years, he has finally and completely retired from Carbone-Lorraine Industries. While Ed was moving up the ladder to eventually become the chair, the company grew from 40 employees and under $1 million in sales to 1,500 employees and over $100 million in sales. Two years before retirement, Ed started a personal financial planning service with a friend. They are now seven. It's a second career, "busy, not profitable, but very enjoyable."

We regret to inform you that **Ben Moore** passed away August 28, 1990. He was in the Navy V-12 program. We extend our sympathy to his widow Nancy.—Co-secretaries: **Andrew Corry,** P.O. Box 310, W. Hyannisport, MA 02672; **Louis Demarkles,** 77 Circuit Ave., Hyannis, MA 02601

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Please send news for this column to: **Clinton H. Springer,** secretary, P.O. Box 288, New Castle, NH 03854

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Please send news for this column to: **Jim Ray,** secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

47 45th Reunion

Well, it was too good to last. We had several months when we had long letters from classmates but none this month. Only one item to report and that, sadly, is a delayed obituary. **John Logan** died in October 1989. John had worked for the Naval Research Laboratory until his retirement about ten years ago. He is survived by his wife, Anne Richardson, of Columbia, Md.

How about some more letters for us to pass along to our classmates?—**Robert E. McBride,** secretary, 1511 E. Northcrest Dr., Highlands Ranch, CO 80126

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The mailing about our September 27-28, 1991, Martha's Vineyard Reunion produced responses from 34 classmates. On May 10th, the hotel had deposits from 26 classmates and from six members of the class of '49. A partial list of attendees includes **Geraldine Haughney, Dennis Allegretti, Larry Manoni, Ken Brock, Lou Kreek, John Kirkpatrick, Ben Ball, Bob Ormiston, Warren King, Tom Zsembik, Bill Maley,** and **Bill Katz.**

George Clifford reports that the inauguration of MIT's new president, Charles Vest, was well done. George was invited to be in the procession as a representative of alumni/ae. He marched next to Claude Brenner, '47. . . . **Peter Saint Germain** is president-elect of the Alumni/ae Association. Peter walked in the inaugural procession with the MIT Corporation. Also at the event was **Graham Sterling,** Jean and **Milton Slade.**

Al Davidson retired from Grumman Aerospace last year as part of the down-sizing that has affected the U.S. defense industry. Rheba also retired from her job. They are enjoying the fruits of retirement living in Baldwin, Long Island, N.Y., in the home they bought when they were first married. Al has taken up several new hobbies in addition to his prior hobbies. They are living in low key, but very pleasant style. Their children live in Georgia, Texas, and Connecticut providing good excuses to travel and visit. One daughter is married to a naval officer who is a navigator on a nuclear submarine. Their first grandchild is a boy.

Dick Snow retired last year and plans to stay in Lumberton, N.C., where it is possible to play golf year round. So far, Dick and his wife, Carolyn, have little idle time. For his last ten working years, Dick was chief chemist at Eaton Corp., Golf Grip Division. . . . **Bernie Gordon** was elected to the National Academy of Engineering. Bernie continues his leadership of Analogic Corp. as president and chief executive officer. . . . **Jay Lathrop** is professor emeritus of electrical engineering and computer engineering at Clemson University. He received the first Outstanding South Carolina Electrical Engineering Educator Award for his pioneering work in the development of the integrated circuit as well as his contributions to EE education in S.C. The South Carolina Council for the IEEE has initiated three annual awards to provide recognition for those contributing to EE in the state. In the future, one award will be known as the Jay Lathrop Outstanding South Carolina Electrical Engineering Educator of the Year.

Arnold Smith died in March. He and his wife, Marjorie, had been living in a retirement center in Haverford, Pa. Arnold was in the Army Air Force 98th Bomb Group during World War II. He was involved with the Apollo space program in 1960s as an employee of General Electric, where he worked from 1963 to 1989. As a volunteer he served as an officer in a community theater, a recreational community, the Masons, and in his World War II group. On behalf of our classmates I extend our sympathy to Arnold's wife, Marjorie, and his family.

Robert McDonagh died in a hospital near his home in Hingham, Mass. He was the state's acknowledged expert in bridge design, repair, and maintenance and spent more than 40 years with the Department of Public Works in Massachusetts. In addition to administrative duties, he was a featured speaker at numerous forums on transportation topics. . . . **Frank Ryan** died in January in Chatham, N.J. . . . Col. **Robert B. Burlin** died in Melbourne, Fla. After graduating from West Point in 1943, he served in Burma on the Ledo Road during World War II. Later he worked on the DEW line, a reactor in Antarctica, and as acting director of a construction group in Vietnam.

Capt. **Robert Delgado** died in Sandwich, N.H. After graduating from Annapolis, earned a degree in electrical engineering at MIT. He retired from the Navy in 1972 as supervisor of shipbuilding at General Dynamics in Quincy, Mass.

On behalf of our classmates I extend our sympathy to the wives of these classmates and to their families.

Tom Zsembik called from his home in Beverly Hills, Fla. Tom remarried after his wife of many years died. He was on campus for a seminar on Systems and Forecasts. He has always followed

Jay Forrester's work. Tom is active with the Kiwanis Club in Florida. . . . **John Kirkpatrick** sent his regards with his reservation for the September 1991 reunion.

My daughter, Amy Billett, has been an instructor on the faculty of Harvard Medical School since 1989. Recently she particpated in a symposium with other faculty and the presence of her name on the bulletin made me feel good. I sent a copy to **Jim Adelstein,** who has been on the Medical School faculty for many years. Jim's response was to suggest that my buttons must be popping.—**Marty Billett,** secretary and president, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

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Missing persons bulletin: Ted Davis, '47, is trying to locate **Rowland B. Vance.** Our outdated 1984 listing for him was associate director CDX Television, 524 W. 57th St., New York, NY 10019. If you have any more recent information, please send to Ted at: 2870 So. Golden Way, Denver, CO 80227.

Dot and **Jim Christopher** plan to visit their son in Toledo this fall. And, Jim tells me, they will travel by 28-foot auxiliary sloop the whole way. Now I know for a fact that there is a lot of dry land between Andover, Mass., and Toledo, Ohio. So I asked: "That boat got wheels?" "Nope," said Jim. "You can get there entirely by water. Just get out a map and look." So I did. Sure enough, all Jim has to do is sail up the Hudson River to Troy, N.Y. From there, take the Erie Canal to Lake Erie and Toledo is 250 miles away at the other end of the lake. But I've got a problem. Namely, if I am reading this map correctly, the Erie Canal goes right over Niagara Falls! Now, either the map is wrong or I am reading it wrong because it is against the law to go over the falls in a 28-foot sloop.

Once in Toledo, the Christophers will have travelled 1,000 miles. On their return, via the St. Lawrence Seaway through the Maritimes, they will cover another 2,700 miles.

Jim and Dot can do all this because he is now retired from AT&T Technology (formerly Western Electric) where he was a member of the Information Systems Staff. I am sure I reflect the sentiments of the class in wishing them smooth sailing.—**Fletcher Eaton,** secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

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Please send news for this column to: **John T. McKenna,** secretary, P.O. Box 376, Cummaquid, MA 02637

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The Columbia University Charles Chandler Medal was presented to **Howard E. Simmons,** in recognizing his original and basic research in synthetic, physical, theoretical, and topological chemistry. At the presentation Howard delivered the 1991 Chandler lecture entitled "Making Rings." The award cited his contributions in devising methods to synthesize new molecules and novel materials having previously unavailable or unknown properties. His work has focused on telescoping critical chemical and physical features into fundamental mathematical properties that can be used to design the syntheses of new structures. He is coauthor of the book *Topological Methods in Chemistry.* Howard joined the Du Pont Co. in 1954 and is currently a vice-president and senior science advisor of their Central Research and Development Laboratory.

After 30 years with Westinghouse, **Al Boltax** retired and started his own consulting business. Al is an expert in nuclear reactor materials technology. He is working for the national laboratories and the nuclear industry. Al writes that he is playing tennis four times a week and loves his Yamaha V-50 synthesizer.

We received the sad news of the passing of **Eric Robba** in March. He had been a supervisor of administration and engineering at Electric Boat in Groton, Conn. In addition to his professional career Eric had an extensive career in public service. He served on the building committee responsible for the construction of several of the major schools in Groton. After serving as town moderator, he was elected mayor in 1985. We wish to extend our sincerest condolences to his wife, Virginia, and to his brother.—**Martin N. Greenfield,** secretary, 25 Darrell Dr., Randolph, MA

52 40th Reunion

Bruce G. Collipp was one of 13 alumni recently elected to the National Academy of Engineering. He is a marine engineering consultant in Houston. . . . A press release from the ASME call attention to a recent article by **John R. Dixon,** professor of mechanical engineering at University of Massachusetts, in the society's publication *Mechanical Engineering.* In the article, Dixon criticizes current education methods in engineering design. He says, "Educators should give top priority to teaching, not past or even current engineering design practices and applications, but the cognitive fundamentals on which current best practices are based and on which improved future practices will be based." I'm afraid that as far as I am concerned, top priority will have to be given to learning what "cognitive" really means.

When last we heard from **James Weissburg,** he was trying to recover from his five-year consulting stint working on the Three Mile Island problem. He is now consulting in western Pennsylvania on many small projects, including foundry equipment and a color graphics system. He has a first grandchild, Leah Amy Garner, in Houston. . . . Now **Robert Krulee** has ten grandchildren. He writes that he has just turned 65 and still enjoys working. He also enjoys sailing and entertaining his grandchildren.

Each year the student financial aid office reports to **Art Turner** on the Class of '52 scholarship fund, and Art duly forwards the letter to me. Thanks to this arrangement, I hear from Art more frequently than I otherwise would. Art was disappointed to learn that last year's scholar, Daniel Loera, dropped out and disappeared, something, as the letter pointed out, that doesn't happen very often with able students. The current scholar is Douglas Turnbull, '93, a Course VIII student from Urbana, Ill., who hopes eventually to teach. The letter ends with the no doubt accurate statement that they could always use more scholarship money. Consider yourselves duly notified.

Art's former roommate, **Ed Margulies,** left physics for medicine, and has had a long and successful career as a surgeon in Highland Park, Ill. Ed writes, "Paulette recently began teaching Spanish at Highland Park High School. Sarah is a sophomore at Cornell. Dan, a high school senior, has excluded Tech from his choices among the good colleges. Larry, our caboose, is a sophomore this year. I look forward to seeing you at the reunion." And I look forward to seeing you.—**Richard F. Lacey,** secretary, 2340 Cowper St., Palo Alto, CA 94301

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Please send news for this column to: **Gilbert (Gil) Gardner,** secretary, 1200 Trinity Dr., Alexandria, VA 22314, (703) 461-0331

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Please send news for this column to: **Edwin G. Eigel, Jr.,** secretary, 33 Pepperbush Ln., Fairfield, CT 06430

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Austin Baer retired in 1990 with the sale of Roton Corp., a manufacturer of patented continuous hinges, to Hager Hinge Co. He is moving to Ridgway, Colo., where he will be ranching and will be available for limited product development consultation. Sounds good to us! . . . **Frank Leitz** escorted the first group of Scouts to be involved in a cultural exchange with the Soviet Union on their trip to that country. . . . At the annual awards banquet of The International Society for Optical Engineering (SPIE) held last July in San Diego, **Roger Reiss** was honored as a new Fellow of SPIE. SPIE is a nonprofit technical society dedicated to advancing engineering and scientific applications of optical, electro-optical, and opto-electronic technologies. Roger was recognized for his important research and contributions as an author and educator in the field of optomechanical engineering and precision instrument design. He is employed by Lockheed Missiles and Space Co. and resides in Mountain View, Calif.

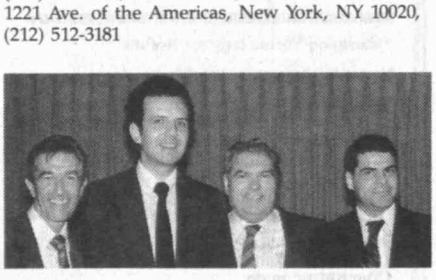
We regret to have to report the death of **James Bartsch** on March 1 from injuries received in an auto accident. He was born in Montclair, N.J., and attended the Choate School before entering MIT. In 1976 he received a law degree from the University of Nova in Florida. He was the owner of Quest Technique in Manchester, Mass., a consulting business. In addition to his wife, Brenda, he is survived by four sons, a daughter, two stepdaughters, two grandchildren, a brother and a sister. Memorial contributions may be made to the Crombie Street Shelter, 9 Crombie St., Salem, MA 01970.—Co-secretaries: **Roy M. Salzman,** 481 Curve St., Carlisle, MA 01741; **James H. Eacker,** 3619 Folly Quarter Rd., Ellicott City, MD 21043

56 35th Reunion

The 35th Reunion is here as of September 26-29. Trust you will be there.

Frank Amoroso was the instructor for a four-day course in "Digital and Analog Modulation" in the Washington, D.C., area in April. Frank also authored the article "Should You Fire Up or Calm Down," subtitled "The right emotional balance on court can help you play better," in the May issue of *Tennis* magazine. . . . **Bernardo Blashchitz** looks forward to our reunion and will make the trip from Caracas, Venezuela. "Bernardo challenges **Tom Comparato** to bring his racquet and tennis gear so that he can beat him as he did 35 years ago." . . . **Ward D. Halverson** is still at Spire Corp., and is looking for an interesting and (we hope) profitable 1991. . . . Gloria and **Jim Mozzicato** have made plans to attend the reunion. Gloria sent in the picture (shown below) of a couple of generations of MIT graduates taken during the fall of 1988.

See you at the reunion.—Co-secretaries: **George H. Brattin,** 39 Bartlet St., Andover, MA 01810, (508) 470-2730; **Irwin Gross,** Sweets McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10020, (212) 512-3181



Two generations of MIT graduates: Left to right, Paul Cianci, '56, Rick Kovalcik, '79 (husband of Jim and Gloria Mozzicato's daughter Susan), Jim Mozzicato, '56, and son Richard Mozzicato, '83.

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Please send news for this column to: **John Christian,** secretary, 23 Fredana Rd., Waban, MA 02168

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Please send news for this column to: **Mike Brose,** secretary, 1619 Greenleaf Blvd., Elkhart, IN 46514

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Please send news for this column to: **Allan S. Bufferd,** secretary, Office of the Treasurer, MIT, 238 Main St., Suite 200, Cambridge, MA 02142

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I start with a bit of old business. **Jorge Dominguez** sent me two photos from the 30th Reunion, and as a Course Xer I had to pass them along. The one with 15 stalwarts is the Course X delegation to the festivities on the Cape; the other, with 14 classmates, represents all the other courses. I do not recall the Course X crowd as being an excessively partying group, although we did take the same field trip every year—to the Carlings brewery in Natick.

Jorge also writes that he recently heard from the Alumni/ae (I don't want to appear sexist, but isn't there a single word to acknowledge that there are *graduates*—that's a good word—of both sexes rather than tacking on a Latin feminine plural ending?) Association that there is a recommendation to use our class endowment for innovation in education to help develop the Integrated Studies Program (ISP). The Fall 1990 issue of *MIT Spectrum* describes ISP as a six-year old program that offers freshmen (and women) an alternative to the traditional curriculum. The students take their physics, chemistry, and math in mainstream lecture halls, but have separate recitation sections. The centerpiece of ISP is its humanities course, which covers technologies in their historical and cultural perspectives. Technologies covered begin with cooking and progress to weaving, blacksmithing, clocks, internal combustion engines, and computers. *Spectrum* points out that ISP is not a "course where laid-back students can rack up MIT credits by stringing beads, [but] has a reputation as intellectually demanding. . . . " I'll keep you posted.

Leslie Lamport, a member of the research staff at Digital Equipment Corp's Research Center in Palo Alto, Calif., was recently elected to the National Academy of Engineering. Les has been a member of the Research Center since 1985, and was cited for his contributions to the theory and practice of concurrent and fault-tolerant computing. Leslie also is an associate editor of ACM *Transactions on Programming Languages and Systems, Science of Computer Programming, Distributed Computing,* and *Mathematics Letters.* Congratulations, Les! . . . Joining Leslie in the prestigious NAE membership is **Kenneth Reinschmidt,** president of Stone & Webster's advanced systems development services. Congratulations to you, too, Ken! . . I also received word that **Robert Eller** has been named a vice-president of Charles River Associates, Inc., in Boston. Bob will be guiding CRA's market assessment program, using his experience in automotive plastics, compounds, composites, and thermoplastic elastomers. . . . **Herbert Shanzer** has recently been named president of Alloy Computer Products in Marlborough, Mass. Herb had formerly been a consultant.

A news release from UConn announces the naming of **Harold Brody** as dean of the school of engineering. Harold comes to UConn from the University of Pittsburgh where he had been a professor of materials engineering since 1966, and chairman of the department of metallurgical and materials engineering from 1970-1979. Harold also has held a part-time appointment at MIT where his collaborates on solidification research.

The MIT Press has recently published *From Animals to Animats,* edited by **Stewart Wilson.** The publication is the proceedings of the First International Conference on Simulation of Adaptive Behavior and describes behaviors and other mechanisms that allow animals and, potentially, robots to adapt and survive in uncertain environments. Stewart is a scientist at the Rowland Institute for Science, Cambridge, Mass.—**Frank A. Tapparo,** secretary and class agent, 15 S. Montague St., Arlington, VA 22204

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Some honest-to-goodness written messages this month. Thank you. Thank you!

Harry Baya says he is a full-time software developer for MacIntosh Computers and finds the work challenging and exciting. Harry's older son Matthew graduated from Antioch this spring and is thinking about MIT as a graduate school. Paul, the second son, is off to college (unknown at this writing) in the fall. . . . **Robert Ried** writes, casually, that he is chief engineer for Lunar/Mars exploration at the NASA Johnson Space Center. WOW! . . . Also in the WOW category is **Steven Kleiman**'s report that he got an honorary degree. Doctor Scientarium honoris causa, from the University of Copenhagen in Denmark a couple of years ago. WOW!

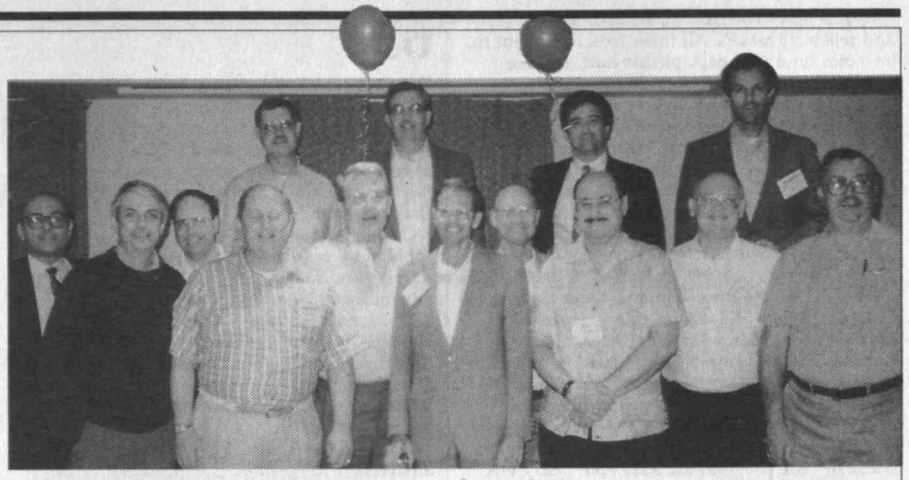
Continuing in the WOW vein, I got a fascinating letter from **Sam Williamson,** who writes that he is University Professor at New York University, an honor similar to Institute Professor at MIT. Congratulations, Sam! He writes a bit of history: "After I got an ScD in physics from the Institute in 1965, I enjoyed a year at the University of Paris thanks to a National Academy of Sciences-National Research Council postdoctoral fellowship. My wife Joan and I returned to try California living, and I joined the North American Aviation Science Center to do basic research in superconductivity and magnetism. Those were heady days, since North American was prime contractor for the Apollo project to reach the moon. One side issue in our community that attracted my attention was a curious misconception in air pollution control regulations, which focused exclusively on putting limits on the concentration of pollutants emitted by a source. If you pick up a book on dispersion theory, you quickly realize that the initial concentration is not as important as the mass emission rate, since mixing with the outside air is a much more important factor for what you breathe downwind. The Sierra Club enticed a group of us amateurs to spearhead an attempt to have the county adopt the first limit in the world for mass emission rates, and I ended up as chair of the Ventura County Citizens Committee for Clean Air. It was a difficult struggle, but ultimately the county supervisors accepted the notion—no more than 150 tons per day of nitrogen oxides from any one source—and now such limits are an accepted concept." Sam goes on to describe his moving on to the University of California, where he wrote *Fundamentals of Air Pollution,* and his subsequent move to New York University in 1970. The Williamsons moved to Greenwich Village, where they have stayed, and Sam set up an ultra-low temperature lab. Over the years the lab has moved into imaging magnetic fields in the brain, and New York University made him a professor of both physics and neuroscience. A wonderful letter and career, Sam. Thanks and WOW!—**Andrew Braun,** secretary, 464 Heath St., Chestnut Hill, MA 02167

62 30th Reunion

John M. Cozzolino, Jr., teaches management at Pace University in Lower Manhattan. John started up the Underwriting Education Institute at Pace

The 30th Reunion of the Class of 1960 at the Ocean Edge Resort in Brewster, Mass., in June 1990, brought together a large number of Course 10 graduates. In the photo (top right) are chemical engineering majors (front row, left to right): Frank Tapparo, Tony Fazzari, Jerry Yarbrough, Morris Salame, Dave Geisler, Dick Cahaly, Bob Hodges, Earl Pike, Jaime DeSola, and Mike Kasser. (Back row) Bill Blatchley, Len Tenner, Joe O'Connell, Bob Gurnitz, and George Schnabel.

Other graduates represented at the 30th Reunion are: (lower photo; front row, left to right) Dick Levine, Dan Whitney, Dave Staelin, Barton Krawetz, Tom O'Connor, Dick Oeler, Tim Hart, Larry Elman, Rusty Troth, and Jorge Rodriguez. (Back row) Jerry Kaiz, Burg Rhodes, Joe Cantanzaro, George Meyers. Brian O'Connor also attended. (photos: Sara Levine)



for underwriting decision making in the property/casualty insurance industry. Call on John for continuing education needs in the property/casualty insurance field if you are in the New York area. . . . **Martin C. Poppe, Jr.,** is still president of Cambridge Engineering (named after Cambridge, Vt., his home at the time he started the business) after 18 years. Martin is a consultant in navigation and electronic systems. While he is considering retirement he claims that it is tough to quit when you work for yourself. I guess it's hard to complain about your boss or to blame your troubles on a lack of understanding by your supervisor when you're in business for yourself. At least you don't have to worry about receiving a "pink slip."

Herman M. Schneider has been named a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) "for contributions to the design of insulation systems for high voltage AC and DC transmission lines." This honor is conferred by the Board of IEEE on individuals who have made "important contributions to one of the fields designated by IEEE resulting in an improved quality of life for society." Herman is a senior research engineer for high voltage technology at the High Voltage Transmission Research Center in Lenox, Mass., operated by the General Electric Power Systems Engineering Department for the Electric Power Research Institute (EPRI). Perhaps Herman can help us to shed some light on the latest environmental fad: potential health dangers from electromagnetic fields. . . . **Timothy Coffey** has received the 1991 Delmer S. Fahrney Medal from The Franklin Institute for research in atmospheric physics and related plasmas and for his distinguished management of the Naval Research Laboratory in Washington, D.C. The Fahrney Medal is awarded annually to an individual who has demonstrated outstanding leadership in science and technology.

James A. Anderson is co-editor of *Neurocomputing 2: Directions for Research* published by the MIT Press. According to the publication announcement: "*Neurocomputing 2* collects 41 articles covering network architecture, neurobiological computation, statistics and pattern classification, and problems and applications, that suggest important directions for the evolution of neurocomputing." James was also co-editor for the earlier volume *Neurocomputing* which "has become an established guide to the background of concepts employed in this burgeoning field." . . . **William I. Koch** is back in the news with a feature article from the San Diego, Calif., *Tribune,* about his entry into the America's Cup competition. It also provides insights into his personal history and his drive to excel in whatever he undertakes. It seems that David Conner, his principal competitor in the 1992 America's Cup qualifying races, is about to sponsor Bill's membership in the San Diego Yacht Club. The news feature discussed Bill's great success with new designs and technology with "Matador" in the maxi boats, a class of sailing vessels somewhat larger than the 10-meter America's Cup versions. It looks like Bill is gearing up for a major challenge on the West Coast. We wish him well in his efforts to represent the United States in the classiest sailing competition of the 20th Century.

Thanks for all the news this month, and if you want to see your name in this very column, please drop me a line when you get the chance: **Hank McCarl,** secretary, P.O. Box 352, Birmingham, AL 35201-0352

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Marty Schrage sent me a newsy letter that starts off this month's pretty news-filled column. Marty, who is our class agent (I don't think that means he spies on the Soviets and Iraqis, but I am not sure) got married for the first time about four years ago. He and Andrea had Seth Alexander Schrage on October 6, 1990. "He is as far as [Marty is] able to tell, the cutest child in the Western hemisphere." Now I happen to know that my daughter Julie, 2, really is the cutest. Still, the photo Marty sent puts Seth right up there. . . . What about the rest of you out there: any kids or grandkids to crow about? Send the entries to the address at the end of this column.

Anyway, Marty and **Ira Blumenthal** and **Pete Van Aken** have now completed five years with their company, Xanalog. They are growing despite what now is still a weak economy. Xanalog does software and real-time equipment for engineering analysis of nonlinear dynamic systems and of sampled-data controllers. (What a mouthful.) They have hundreds of installations in over 15 countries. Must be doing something right. Marty lives in Chestnut Hill, Mass.

Another entrepreneur is **Martin Schlecht,** who is head of MIT's power electronics lab. He is the chief technical guy of a company called Zytron in Bedford, N.H., which specializes in ASIC power supplies. They make a palm-sized (I got a b/w glossy) 400-watt, 500-Khz unit for hostile environments. Dig this: their phone is 800-DC POWER. I wonder what they had to get that one.

Carl Dover is group leader in theoretical nuclear physics at Brookhaven National Lab, and adjunct professor of physics at Yale. . . . **Bob Dinsmore** is based in Santa Monica, with a nationwide design consulting practice for hospitals and high-tech research labs. . . . **Steve Zilles** remains at IBM's Almaden research center, doing electronic imaging. His wife is an instructor at West Valley College. Son Karl is in math at Pomona College, and Craig is in mechanical engineering at the 'Tute. Steve has completed a term as chair of Computer Professionals for Social

Responsibility working on civil liberties and risk and reliability issues. All three took a moment to jot notes on a mail-back pledge card, and we thank them. Why don't you do the same?

At **John Wawrzonek**'s Gallery in Worcester, Mass., there was a two-month showing of the works of 26 photographers "both famous and little known," using the dye-transfer process, in which John is a leading expert. It's a pity that the lead time for this column is so long that I cannot tip you to John's shows in time, but give him a ring at (508) 798-6612 to find out what's cooking directly.

Finally, I have a press clipping about **Groves Herrick,** of Blue Hill, Maine. He is professor of engineering at Maine Maritime Academy at Castine. The academy just graduated its first class in a five-year program in marine systems engineering. He remarked, "It's very unusual . . . to find students who can perform on a high level in both [design engineering courses and training cruises]." The program includes both heavy engineering courses (statics, thermo, differential equations, etc.) and 180 days industrial practice at sea, and leads to an SB degree.

Let's hear from you. Don't forget, here at the old ranch we accept a variety of communications modalities: voice land-line (phone), snail-mail (U.S. postal service), and electronic mail via CompuServe. So choose your modality and get crackin'. See you next time.—**Phil Marcus,** secretary, 3410 Orange Grove Ct., Ellicott City, MD 21043, (301) 750-0184, CompuServe 72047,333

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The deadline notice from the editor said it's the August/September issue and the calendar says that today is April 19. It's tough to think summer when the golf course at Hanover (N.H.) Country Club hasn't opened for the season yet!

Down south in Atlanta, where I'm sure it's warmer, the *Georgia Tech Whistle* reports that **Len Parsons** has been honored by the American Marketing Association for 25 years of contributions to the profession of marketing. Along the way, he has been very active in AMA affairs, including chairing national conferences and serving on editorial boards for several journals. Concurrently, the *Whistle* noted that Len had his biographical sketch included in *Who's Who in America 1990-1991.*

Now, it's Alumni Fund note time. **Don Silversmith** wrote that he has been at Wayne State University in Detroit since September 1988 as associate dean of Engineering for Research and Graduate Studies. Don's older son, Jolyon, is completing his freshman year at Harvard. . . . **John Enyedy** is now president of Abra MacDabra Software, a developer of Macintosh human resources software. . . . **Bernard Morris** wrote that his son Jamie started at MIT in September 1990 as a joint math/physics major and was happy to find that the Institute is just as much as his father had promised. Jamie also reported that it was much easier than promised. Bernard asks, "Too easy?"

Next, news of transitions—one recent, one not. **Ron Lawson** writes that his company was recently acquired by EG&G, opening up significant opportunities for growth and expansion. He notes that chief engineers of EG&G divisions get 10 times the number of phone calls that chief engineers at small companies get. Ron also points out that they accumulate many more frequent flyer miles. . . . Five years ago, **John McNamara** left Digital Equipment Corp. to join Stratus Computer in Marlboro, Mass. More recently, he has just finished co-authoring a new book with C. Gordon Bell ('56); it is called *High Tech Ventures.*

Less than three years till our next reunion. Write now to beat the rush of classmates sending news in anticipation of the event!—**Joe Kasper,** secretary, RR 2, Box 4, Norwich, VT 05055

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George Kossuth reports that he is still at Draper Laboratories and recently got his "chair" as a member of their Quarter Century Club. He continues to work in computers for the oceanographic systems department, and is now developing a fault-tolerant computer system on a homegrown Draper system.

George reports that his daughter is entering her sophomore year at MIT, perhaps in materials science, and his older son is entering his fourth year in the engineering intern program of Course XVI. As an employee of Draper from the "good old days," George has been able to send the kids to MIT with tuition paid by Draper under an old agreement. His other son is a freshman at St. John's Prep and promises to find a school "with a better football team."

George and his wife just celebrated their 24th anniversary, and report that one advantage of staying with Draper this time is that they are rapidly approaching the point where they can burn the mortgage!

The only bad news is their interest deductions are disappearing. They run a 17-foot sailboat on the lake in Wakefield in the summers. In his spare time George continues to be a Scoutmaster.

Bill Collins reports that his company builds Mexican Maguiladoras, and that he finished a project in San Diego in January to return to his office in McAllen, Tex. Bill has three children, ages 6-12. . . . **Regina Herzlinger** was recently named a director of C.R. Bard, Inc. Regina continues to be a teaching leader in health-care management at the Harvard Business School.

I ran into **Steve Dangel** at a meeting of the MIT Club of Boston. Steve continues to build custom arc welding robots. He has operated his own company for years, doing "one of a kind" machinery. . . . **Ed Hoffer** continues his private practice of cardiology and internal medicine at Framingham. He was recently elected a fellow of the American College of Medical Informaters.

Ed Burke was recently appointed director of Advanced Systems in the Center for Intelligence and Special Programs at MITRE. Ed worked at MITRE from 1971 to 1982, and rejoined the company after a stint at Data General, where he was senior director, Corporate Product Development. Ed lives in Exeter, N.H.

I will be membership chair for the MIT Club of Boston this year. Those of you in the area can expect to hear from me about joining and attending area alumni/ae events.—**George McKinney,** secretary, 33 Old Orchard Rd., Chestnut Hill, MA 02167, (617) 890-5771

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Paul Eckstein wrote to bring us up to date on his activities of the past 25 years. He stayed at MIT to get an SM in 1967, then went to Albert Einstein College in New York to get an MD degree. For the past 14 years he has been doing cardiac surgery with a group in Tampa, Fla. His group was the eighth most active cardiac transplant program in the country last year. He is now moving to Colorado for a change in scenery. He and Sue have been married since 1970, and have two boys and two girls, the oldest of whom is at BU. . . . I came across a review of *Lonely Hearts of the Cosmos,* by **Dennis Overbye.** It's a history of cosmology and a picture of the people who do it. Sounds like good reading. . . . **Bill Roesner** writes: "After skippering a 50-foot sailboat in the British Virgin Islands last February, I am back and looking forward to the completion of my 13th branch bank project for Shawmut Bank. Given the current architectural business climate in New England, however, and the fact that all the kids will finally be graduated this spring, Elizabeth and I are looking forward to doing a little extra sailing in Maine this summer."

Ted Gull was mission scientist for the Astro-1 payload at the Marshall Space Flight Center. Astro-1 was carried aloft by the Space Shuttle Columbia last December. . . . **Tom McDonough** says that his next book has been postponed until December. He has become a consultant to the Committee for the Scientific Investigation of Claims of the Paranormal, is still teaching at Caltech, and is coordinating the SETI program of the Planetary Society. . . . **Ken Browning** says his title "finally caught up with my job." He is now vice-president for business and finance at Illinois Wesleyan University in Bloomington, Ill.

Matt Fichtenbaum is still senior principal engineer/staff scientist at Genrad, designing automatic test equipment. This year he made conference presentations in Sweden, England, and Washington, D.C. He is improving as a Swedish fiddler, and has a daughter, Rachel, 9. . . . **Woody Stoddard** is a research profressor at the Alternative Energy Institute at West Texas State University. He is engaged in design and R&D on wind turbines for utilities and agriculture. He would welcome visits from MITers who find themselves in the Texas panhandle. . . . **Jerry Abraham** was looking forward to the 25th reunion and to his daughter's graduation from Wellesley on the same weekend. He has "only three more" to put through college—the last will be Class of 2006! He has added major teaching responsibilities as pathology course director for the second-year medical school class, and has been promoted to professor of pathology at Upstate Medical Center of SUNY in Syracuse, N.Y. The goal of a sabbatical year seems to be receding.—**Jeff Kenton,** secretary, 7 Hill Top Rd., Weston, MA 02193

67 25th Reunion

Our 25th Reunion committee has been busy making plans for our big reunion next June 5-7. Please plan to attend, since you will enjoy it. The response to date has been excellent. On Friday evening there will be a reception at the MIT President's House, followed by a dinner dance. There will be a fun family activity Saturday afternoon (clambake/BBQ/picnic), and a party in the evening at the MIT boathouse or other hot spot. Planning for Sunday continues. Give **John Rudy** a call at (508) 858-5768 (work) or (617) 861-0402 (home) if you wish to join the reunion committee and help out.

David Schramm is co-author of a new book, *The Shadows of Creation: Dark Matter and the Structure of the Universe* (W.H. Freeman, 1991), which traces the steps that have led scientists to deduce the existence of dark matter. The book is a fascinating detective story about missing matter and the fate of our universe. It addresses some of science's toughest and most compelling questions. Is the universe open or closed? Are we headed for the Big Crunch or the Big Chill? The other author is Michael Riordan, who also had MIT roots—S.B. '68, Ph.D. '73. Dave has written over 100 scientific articles and is also co-author of *From Quark to the Cosmos.* Dave was elected to the National Academy of Science in 1986 and is also a member of the American Physical Society. An avid skier and mountain climber, Dave lives in Chicago where he is professor of physics at the University of Chicago.

Murray Katcher, MD, PhD, was recently appointed director of community health services at the University of Wisconsin's Madison Medical School. Murray was formerly the state maternal and child health director for Wisconsin. . . . **Jeff Dodson** writes that he is "kidless, married, happy and doing dentistry in my home." In the last three years he has reinvented the reflectance spectrophotometer and is currently finishing programming his HP425 scientific calculator to handle color matching problems in his acrylic painting. He is trying to input a little left-brained creativity into his art, and would like to hear from any readers having leads on this process, as he finds color matching a difficult task. . . . I am

1901–1991

Frederick G. Fassett, Jr.
"Friend, Counselor, Teacher"

Former Dean of Residence Frederick Fassett died January 7 in Damariscotta, Maine, at the age of 89.

While a student at Colby College, Fassett worked at the Waterville, Maine, *Morning Sentinal* as night-editor. With this experience and a degree in English, he instituted the journalism course at the University of Maine in 1927. He only taught there three years, but, was the most beloved teacher on campus. Years later, a student who succeeded in a journalism career remembers him ending all his classes—continuing the lesson after the bell had rung—with the sage reminder that "sufficient unto the day is the evil thereof."

Fassett was appointed an instructor in English and history at MIT in 1930 and chairman of first-year instruction in the Department of English in 1934. In 1939, he took over as editor of *Technology Review,* following the term of James R. Killian, '26. By 1945, when he left to become director of publications and public relations for the Carnegie Institute in Washington, D.C., he had sufficiently endeared himself to MIT students to be named an honorary member of the MIT Alumni/ae Association. In 1951 Fassett was back at MIT, as director of the publications office, as well as director of the Technology Press (now MIT Press), and head of the MIT Summer Session.

When Fassett became associate dean of students in 1952, he was relieved of his Summer Session duties. That same spring his name hit the media with the ebullience of his student charges. He was charged with "disturbing the peace" while pleading for leniency on the behalf of 17 students facing charges

at the East Cambridge District Court. The brouhaha arose out of a "raid" by some 200 MIT students on a Radcliffe College dorm in quest of "dainty souvenirs," according to the *New York Times.* The evening began with students dropping water-filled balloons out of windows onto passersby and with a bonfire rally outside of Baker house, later accompanied by loudspeakers and fireworks. When firemen and police dispersed the students at 10 p.m., one of them suggested the expedition to Radcliffe over a loudspeaker.

In court, Cambridge police officers said they had seen Fassett, then 51 years old, dropping "water bombs" on police cruisers and accused him of inciting the students. The complaint against Fassett, who had tried to persuade students not to leave campus and had never left the campus himself, was dismissed later that week, an absurd case of mistaken identity. President Killian spoke on his behalf, applauding his highly respected and unimpeachable character.

But the dramatic launch to his term as dean of students put him on notice that life would probably not be tranquil when he became dean of residence in 1956, a position he continued until retiring in 1967. Fassett was called on to help students countless times not so notorious, frequently roused from bed for "accidents, incidents and midnight episodes." Before his retirement, the MIT Campus Patrol showed their appreciation of "his cooperation with them in helping students out of legal difficulties that sometimes result from excessively high spirits," presenting him with an MIT seal affixed with an honorary captain's badge and message to "Friend, Counselor, and Teacher."

Last year, the Class of '65, as part of its 25th Reunion Gift, announced a $260,000 unrestricted endowment fund in honor of Fassett. He had initiated the housemaster and tutor system, and "provided a lot of the warmth on campus," said reunion gift chairman William Brody.

Since his retirement from MIT, Fassett had served as president of the board of trustees of Skidompha Library in Damariscotta, Maine, where he was instrumental in developing children's services and expanding the library. □

saddened to report the death of Catherine Tarantino, daughter of **Paul Tarantino.**—**Jim Swanson,** secretary, 878 Hoffman Terrace, Los Altos, CA 94024

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Please send news for this column to: **Gail** and **Mike Marcus,** co-secretaries, 8026 Cypress Grove Ln., Cabin John, MD 20818

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George D.J. Phillies, who by virtue of his several MIT degrees is "claimed" by our class and several others, has been elevated to a tenured position as professor of physics at Worcester Polytechnic Institute, where he has been since 1985. The note from WPI says that his research interests include light-scattering spectroscopy, complex fluids, statistical mechanics, and polymer physics, with a biophysics specialization. . . . **Raymond L. Eng** writes that he has just been appointed system engineering manager on the Heavy Water-New Production Reactor by EBASCO Services, the prime contractor on this DOE project. He adds, "I'm finally doing some nuclear engineering." . . . **Gene K. Landy** is now a principal in the litigation department of the firm Shapiro, Israel, and Weiner in Boston. . . . **Gus P. Kayafas,** who seems to be taking on the world, is now president of the Visual Project Center in Pepperell, Mass. He continues as president of Palm Press, Inc., in Littleton, and is also director of the DeCordova Museum and Sculpture Park—if the computer note sent to me is correct. . . . **Stephen Nord** is practicing occupational medicine in Sunnyvale, Calif. His sentiments might be echoed by many of us, "I have large children, a medium-sized house, and a small budget."—**Eugene F. Mallove,** secretary, 171 Woodhill-Hooksett Rd., Bow, NH 03304

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Tim Gilmore writes that he has become board certified in occupational medicine and family medicine. He is the acting director of occupational medicine at Group Health Cooperative, an HMO with 400,000 patients in Seattle, Wash. More importantly, Tim tells us that he has three

daughters, one dog, and one mini-van, but does not live in the suburbs.

We also have a report that **Jim Stenzel** is the president and CEO of Keyfile Corp. in Nashua, N.H., which he and two others founded in March 1989. Keyfile is developing a PC-based, client/server software product for document management. Prior to forming Keyfile, Jim was a founder and vice-president of Adra Systems, a CAD/CAM systems manufacturer. Good luck in your new venture, Jim.—**Greg** and **Karen Arenson,** secretaries, 125 W. 76th St., Apt. 2A, New York, NY 10023

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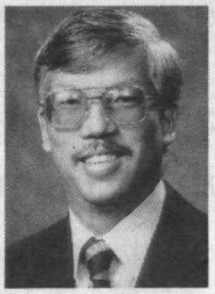
Oops. I missed the July 1991 issue. The notes ended up in my file instead of in the mail. Sorry. **Jim Mannoia** writes: "Is there anyone from '71 in the Santa Barbara area? The Los Angeles group is active, but it's a distance. I used to do council interviews for admissions but dropped it when I left the country for two years leave at the University of Zimbabwe. I am professor of philosophy and associate academic dean at Westmont College, a Christian College of arts and sciences. I was Course VIII. Married Helen Schroeder. Two children: Jim VI (16) and Eva Marie (11)." . . . **Donald S. Raila** writes: "Peace to you! I just want to thank you for the invitation to our 20th Reunion. Although I am a Benedictine monk here in Latrobe, Pa., and there is no way for me to be present physically, I shall be with you all in spirit and in prayer. May our reunion be a time of joy, gratitude, and renewed fellowship." . . . **Oljan Repic** was named associate director of chemical research and development at the Sandoz Research Institute in East Hanover, N.J. He is responsible for three functions: the prep labs, isotope labs, and process R&D; the common denominator of which is organic syntheses. He says he owes his fondness of and success in organic chemistry to Professor Kent (I love Kempistry) who is able to explain it.

Tom Crosby became a certified photo finishing engineer after passing the CPFE exam of the Society of Photofinishing Engineers. He is currently working at the Dallas plant of QUALE Ex, Inc. which is the largest photofinishing corporation in the United States. You can reach Tom at 1601 North Irving Heights Dr., #105, Irving, Texas 75061. . . . **Diane Feldman Eisenstat** married Barry Eisenstat, '69, in 1974. They have three children, Rachel (12), Jared (10), and Zachary (6). she has a PhD in physical chemistry and an MBA,



Robert Sohval *Terrill Chang*

both from Columbia. After getting an MBA she worked for Mobil until the summer of 1990 and is now in strategic planning at Reuters Information Services in their New York office. . . . **Chia-Mei Tang** has been elected a fellow of the American Physical Society. Dr. Tang is head of radiation and acceleration physics section, Beam Physics Branch in the Naval Research Laboratory's Plasma Physics Division. She was cited "for her pioneering work in the development of computer models and codes for understanding the physics of free electron lasers, quasioptical gyrotrons and laser plasma accelerators." She received BS, MS, and ScD degrees from MIT. She has authored over 60 refereed general publications and has contributed to more than 30 book chapters and conference proceedings. She and her husband, Bertram Hui, and their two daughters, Jamie (9) and Julie (1), live in Potomac, Md.

A. Robert Sohval has been appointed executive vice-president and general manager of Elscint, Inc., the U.S. subsidiary of Elscint, Ltd., a worldwide leader in medical imaging systems. He received a BS and a PhD in physics from MIT, and is a member of Phi Beta Kappa and Sigma Xi. Having joined Elscint in 1979 as a research physicist, in 1984 he was transferred to Elscint's corporate R&D Center in Haifa, Israel, where he directed the development of a new high-resolution CT Scanner. He holds numerous patents in computed tamography and medical imaging.—**R. Hal Moorman,** secretary, P.O. Box 1808, Brenham, TX 77834

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Our first report comes from co-secretary **Wendy Erb.** It was sent through the U.S. mail in January intended for the April issue, but made its way to MIT via England, arriving in May. Without further delay: **Terrill J. Chang** has joined Camp, Dresser & McKee as an associate and senior solid waste specialist in their Detroit office. He is managing the siting and design of a medical waste incinerator and services during its construction in Oakland county. . . . **David C. Harlan,** formerly vice-president of marketing for Louisiana Power and Light Co., has assumed the post of bulk power marketing officer for Entergy Corp. . . . **Roy Schulte** is a software market consultant at the Gartner Group in Stamford, Conn.

Alan Michael Cooper and Liz continue to live in Lynchburg, Va., with their 2-year-old, William, and daughter Elizabeth, who was born in September. Alan is starting his sixth year of full-time public sector psychiatry "trying to balance the rewards of caring for the sickest against the frustrations of working in a progressively less responsive bureaucracy." . . . **Thomas A. Weiss** is now the state engineer/environmental coordinator for the FHA in Montpelier, Vt. . . . **Lawrence S. Bacow** has been appointed to head the Center for Real Estate Development at MIT. He also received the 1990 William S. Ballard Award from the American Society of Real Estate Counselors for his article, "Foreign Investment, Vertical Integration, and the Structure of the U.S. Real Estate Industry."

Now to more recent news: **Mark Mitchell** is a commander in the U.S. Navy and writes, "I've been three years in one place, so it's time to move on—hopefully to the Bremerton, Wash. area. I've headed the Navy Supply System effort to get a handle on our $30 billion inventory and inventory growth. From congressional hearings to leading major conferences to in-depth analysis of archaic financial records—it's been fun. My wife, Konia, and kids, Joe (11) and Elizabeth (7), are looking forward to returning to the west coast. . . . **William Gahl** is chief of the Human Genetics Branch of NICHD, NIH, and continues working on inborn errors of metabolism. . . . **Alan Henricks** has been senior vice-president and CFO of Borland International for the last three years.

Maury Goodman reports that he has been "working on an experiment looking for proton decay in Minnesota and has just proposed an experiment to Fermilab to aim a neutrino beam at our detector from 800 km away. I was also just reelected to the Warrenville city council and am a Brownie leader for 22 first grade girls." . . . **Bonny Kellermann,** after over 10 years as director of the MIT Educational Council, is changing jobs to become associate registrar. Her precision skating team won second place in the National Precision Skating Competition in Anchorage. She is very interested in hearing from anyone who wants to work on the class's 20th (doesn't that make you feel old!) reunion. Call her at (617) 232-7140.

Don Levinstone's latest trek was through northeastern Brazil, whence he showed a creative flare by sending me an Arabian postcard. . . . My latest venture was to run for town moderator in Braintree. I got 2695 votes! Unfortunately, the other guy got 4634.—**Dick Fletcher,** co-secretary, 135 West St., Braintree, MA 02184

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Alan Spoon is the new executive VP and COO at the Washington Post Co., moving from president at Newsweek, Inc. . . . **Scott Davidson** is still at Bell Labs in Princeton, N.J., as a research project manager, doing testing and "pseudo-marketing." Wife Tish is writing free-lance while the girls, 9 and 4, are climbing trees.

Doran Holzer spent November in London working on a software evaluation project at BP's finance office. . . . **Carl Rosenberg** sends one of his too-infrequent lines of verse to us:

"Once again, Academics to serve,
I'm off to join Case-Western Reserve
To find a position in Sleep Medicine
To learn and discover whatever I can." 'Nuf sed.

Ann (McBain) Ezzell is now in her fourth semester of sign-language studies at Madonna College in Livoina, Mich., planning this summer to be manager for the U.S. Fencing Team at the World University Games in Sheffield, England. . . . **Daniel Dern** is speaking at trade shows and science fiction conventions, taking workshops in radio announcing, tap dancing, TV production, and theatrical fencing, plus buying magic tricks, selling ties, and taping *Avengers* episodes—all this when not working as a free-lance technology journalist.

That's certainly a healthier amount of news, which I'll salute by telling nothing of me and my family's exploits—this time. Keep it up. Write.—**Robert M.O. Sutton, Sr.,** secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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"Peace is stronger than war because it heals." So said my favorite book, *A Course in Miracles,* this morning. Keep up the peace. **Dennis Dickstein** leads off the column this month with the great news of the birth of a son, Daniel Robert, born to Susan and Dennis last October. Their other son, Jonathan Michael, is five. . . . "Why do I always pick real estate depressions to make major changes in my life?" The questioner is **Charles**

Calhoun. He continues: "In '74, graduated from the architecture department. In '89-'90, I tried my own development consulting business which went with the market. So now I'm lending on apartment buildings and doing very nicely, thank you! You figure!" Answers will be judged on the basis of neatness and originality. Send them to your faithful scribe whose address appears at the bottom of this column.

Someone whose life must have received a major uplift in the past few months is **Antonio Gellineau.** Antonio is employed at Raytheon Missile Systems Division and he is group leader for patriot support tools. . . . **Peter Kurnik,** in another uplift of note, has been promoted to associate professor of medicine at Robert Wood Johnson Medical School. Peter also serves as director of the Cardiac Catheterization Laboratory at Cooper Hospital in Camden, N.J. . . . **William Chotkowski** is vice-president, engineering, at Keyfile Corp. in Nashua, N.H. They have recently completed second-round financing.

One of the most amazing things about walking around campus at MIT is the astonishing improvement in atmosphere brought about by the greater percentage of women. The campus is so much more friendly and comfortable (or maybe it's just the fact that I don't have three problem sets due this Thursday!) Anyway, I was surprised to receive notes from three women members of our class, with which I close this month's column. . . . "The summer replacement TV show "Northern Exposure" is being filmed in our town [Cle Elum, Wash.]—watch for Jock Young in the background as an 'extra.' And see why we love this geography!" So speaks **Elizabeth Wise** in her note. "I continue to work too many hours to participate in the filming. I'm chief of staff at my local hospital this year."

Catherine Mink is managing computing facilities for Cornell. They're getting into multimedia, developing a course in teaching with software. The house that she and her husband are building is "coming along slowly." It has a photovoltaic power system, it's in, it works flawlessly, and they are energy-independent for electricity. . . . We started off with a birth announcement. We end with a birth announcement. **Beverly Wilson**'s daughter Elizabeth (age 8) "now has a brother Timothy, born last September 30th. I'm getting too old for 'all-nighters' now, luckily Timmy has been a good sleeper since birth!" Beverly is working for Carter-Wallace, a pharmaceutical firm near Princeton, N.J., where she is now the manager for stability and package evaluation in the development of new drugs and formulations.

You know you've been meaning to write. If you haven't written in a year, it's time. It'll make you feel good. Your friends will thank you for it. You'll get to see your name in print! What are you waiting for?—**Lionel Goulet,** secretary, 115 Albemarle Rd., Waltham, MA 02154-8133

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Jonathan R. Sass writes, "I spent New Year's weekend with my wife, Christine, at Talbot House with Bonny Kellermann and others from MIT—a wonderful time, even without snow (and even though I lost a Perquacky). Otherwise, our house is getting fuller—with Candyce at 15, Molly, 4, and another girl on the way in June. Still teaching in Holyoke public schools." . . . Well, **Thomas Campbell** must be a new papa because all his note said was "Molly Gayle Campbell—Class of 2012." . . . **Kenneth S. Rumstay** has been married for 12 years to Sue Ellen McGrath and has two children, Rosanne (6) and Rachel (3). He's an associate professor of Astronomy at Valdosta State College, which is a charter member of Southeastern Association for Research in Astronomy (SARA), along with Florida Institute of Technology, University of Georgia, and East Tennessee State University. . . . **Stephen H.** (for Horatio) **Streifer** was recently elected vice-president, general manager and CFO of International Manufacturing Technologies, Inc., a steel fabrication firm headquartered in San Diego. In September 1990, unto Steve a son was born, Jacob Dakota, who has been sailing since his second month and, no doubt, is a prince of a guy, just like his Daddy. (Congratulations, old friend, I am very happy for you.)

Ralph A. Martin writes, "I have just accepted a position as associate director of the Department of Medicine at Helene Fuld Medical Center in Trenton, N.J., where I will be teaching internal medicine residents full-time." . . . **Ross D. Shachter** was just promoted to associate professor in the Department of Engineering, Economic Systems, at Stanford University, and lives on campus with wife, Ruth, and daughter, Naomi, as resident fellows in Sena House Dormitory. . . . Finally, **George H. Braun,** formerly a Senior Investment Officer at John Hancock Mutual Life Insurance Co., has a new title: vice-president, but the same address, P.O. Box 111, Boston, MA 02117.

That's all for this column. Until next time.—**Jennifer Gordon,** secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036; or 18 Montgomery Pl., Brooklyn, NY 11215

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Please send news for this column to: **Arthur J. Carp,** secretary, Voice Recognition Technologies, Inc., 220 Henley Rd., Woodmere, NY 11598, (516) 295-3632, fax: (516) 295-3632

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Please send news for this column to: **Ninamarie Maragioglio,** secretary, 8459 Yellow Leaf Ct., Springfield, VA 22153-2522, e-mail to hertz@ccf3.nrl.navy.mil.

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Notes this month come to us primarily from the tear-offs accompanying Alumni/ae Fund gifts. Keep those cards and letters (and dollars) coming.

Armen Kasabian writes, "My wife Jan and I have a son, Gregory, born in June 1990. I was appointed assistant professor of plastic surgery at New York University." . . . **Jim Pustejovsky** and wife Cathie Marqusee had their first child, Zachary Alan, in December 1990. . . . **Kendall Jensen** appears to be living the good life out West: "I am writing language system software for Oracle Corp., living in beautiful Santa Cruz, driving my convertible to and fro, and investing in the stock market."

Tom Chung was recently promoted to senior research biochemist in the Department of Virus and Cell Biology at Merck Sharp and Dohme Laboratories in West Point, Pa. (Fit THAT on a business card!) He says that he is enjoying virology.

Your class secretary was honored at MIT in April with the dedication of a crew shell, the "James L. Bidigare, Jr. '78," at Pierce Boathouse. It was a real privilege to pour champagne over the bow of an eight. It was also a good opportunity for us—myself, wife **Diane Curtis,** and daughter Danielle—to visit with friends and relatives who came to the boathouse for the occasion. Classmates who attended were Cantabrigians **Dave Browne** and his wife Yuko Takagi, and New Hampshirites(?) **Al Chock,** wife Bonnie Mason, '79, and son Alfred; and **Pete Lippitt** and friend Betsy. Other MITers who made it were Pete Billings, '73, an accomplished sweep rower and sculler who also was my freshman coach; Jim Pierce, '88, who has rowed in boats representing the United States at the World Games for the past two years; Linda Muri, '85, currently one of the leading scullers in the United States; Dan Gilly, '85, John Miller, '74, former sculling great Dan Chernoff, '80, Chris Dippel, '75, and wife Chris Santos, '76, and kids Ian and Kari; Doug Vincent, '89, Kate Joseph, '77, Roy Russell, '79, wife Robin chase, '86, and kids Cameron and Dylan; Max Seltzer, '18, and even Bill Miller, the lightweight coach during my college rowing career. A big "thank you" goes to Director of Crew Stu Schmill, '86, and to the Friends of MIT Crew for a lovely afternoon.

The next day, **Dave Wiederspahn** accompanied us on our now-traditional Boston-excursion-to-Doyle's in Jamaica Plain, in pursuit of its best and broadest selection of fine beers in the Boston area. Dave is living in Belmont, Mass., and has been involved in the Boston rowing scene after coaching for a number of years at San Diego State. He even accompanied the MIT crew team to Florida this past IAP.

It was a pleasant although brief visit to Boston for us. The family did fit in a trip to Singing Beach in Manchester, Mass., and your class secretary did manage one glorious outing in a single scull on the Charles.

Take a moment today and write or give me a call to tell of your travels, your hobbies, your family, your passions!—**Jim Bidigare,** secretary, 322 Central Ave., Newark, OH 43055, (614) 345-8582

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Lots of baby news this month. **Susan Jane Colley** and William C. Colley III (SMEE '81) had a daughter, Diane Elizabeth, on June 7, 1990. Susan says, "I am on leave from Oberlin College this year, where I am an associate professor of mathematics. I'm spending more time trying to get some research and other work done, but a good part of each day is devoted to getting to know my little mathematician. Unfortunately, her daddy wants her to become an engineer." . . . **Daniel Larner** had another son, Jake, on March 12. He is working on Heterogeneous Distributed Object Systems these days, and is an "extra class ham, call sign WV9Z." . . . **Kenneth Burke** and his wife of two years, Laurie Medvec, were, at press time, expecting their first child in May. Kenneth has an MD from Stanford Medical School and did a residency in pediatrics at Yale-New Haven Hospital. For the last five years, he has been in practice in Essex, Conn., a small town on the Connecticut River, east of New Haven. . . . That's all the news this month.—**Sharon Lowenheim,** secretary, 98-30 67 Ave., Apt. 6E, Forest Hills, NY 11374

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Tom Drake was featured in the February *Discover* magazine article on landslides. Tom studies the dynamics of avalanches by dumping 100,000 tiny plastic beads down a long narrow glass chute. He is currently working at Scripps Institute of Oceanography but his work has taken him as far as Antarctica. . . . **Barry Nalebuff,** professor of economics and management at the Yale School of Organization and Management, is co-author of *Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life,* published by W. W. Norton, N.Y. The book provides a general understanding of and insights into game theory. . . . Navy Lt. **Scott Norton** recently graduated from the Navy's Engineering Duty Officer School. He received instruction on the lifecycle of Navy ships and systems and studied Navy research and development, acquisition, and maintenance . . . . **Barbara Hill Thornton** writes that her architectural firm in Rhode Island is still busy even in the current dismal economy. She also works with the Habitat for Humanity.

Brent Dixon and his wife had their third son in November; Matthew joins Robby (6) and John (4). They are back in Idaho after Brent spent a year at the Pentagon. Brent enjoys being in Idaho and

Liz Bradley, '83, was honored by the dedication of an eight-oar shell this spring donated by the Friends of MIT Crew. Her rowing career at MIT was during 1981-83 and she won a bronze medal in the Open Four at the Women's Collegiate Nationals in June 1983. She rowed on the U.S. national team for several years, going with them to the 1988 Seoul Olympics in the Four with coxswain, where they earned a 5th place. She is now pursuing a PhD in electrical engineering at MIT.

working at the Idaho National Engineering Laboratory where he heads up projects on intelligent software and consults on the side . . . . The two sons (Richard, 5 and Alex, 2) of **Charles Hoffman** are now brothers to Catherine Anna, born in January. Charles also writes that he became an assistant professor of biology at Boston College last fall . . . . Last fall **Robert White** had an all expenses paid trip for 16 days to South America as a representative of the IEEE Power Electronics Society on the IEEE Region IX Colloquium. In December he finished an MSEE at Worcester Polytechnic Institute and in January was elected to the IEEE Power Electronics Society Adcom. The notes were a bit more numerous this month but I know you can do better. Send your news to: **Kim Zaugg,** secretary, 2384 Leslie Circle, Ann Arbor, MI 48105, (313) 665-2365, vayda@erim.org.

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Hi everybody! Hope you all had a great time at our 10-year reunion. I would like to thank **Jim Wilber** and the committee for all their fine work. Here's the news. . . . **Drew Wanderman** wrote that she has been married to Steve Milne, '80, since 1987. Their daughter Skye was born in February 1989. . . . **Jonathan Griep** still works at Digital Equipment Corp. Currently he does software development in Nashua, N.H. His wife Martha also works for DEC in Maynard, Mass. . . . **Kevin Pykkonen** is consulting for Booz Allen & Hamilton in Chicago. . . . **Ernest Craig** completed an MBA at the University of California at Berkeley in December 1990. He now works as a software engineering manager for Rolm Systems in pBX Systems Administration. Son Alex was born on July 2, 1990.

William Chamber is married to Barbara Ernisee. . . . **Samuel Lee** has been working at Rockwell Space Systems Division since 1988. He and his wife have been married four and one half years and have a daughter and a son. . . . **Michael Gerardi** is enjoying his career as a patent attorney in Alexander, Md. . . . **Keith Byerly** is working at Hewlett Packard in Waltham, Mass. He recently accepted a new position within the company as a lab manager. Keith's family includes twin five-year-old boys and a two-year-old daughter.

Marc Chelemer finished an MBA at Stanford in June 1990, where he concentrated in marketing and operations/manufacturing management. While there he stage managed and co-directed the First and Second Year shows and conceived of and organized the first annual arts festival. After graduation, Marc and his wife completed a two month tour of central Europe before setting in New Jersey where they purchased an older home and began remodeling. Marc is working as a business development manager at American NuKEMs Environmental Systems Division where he markets design and engineering services to the waste/hazardous substance management industry.

Saqib Jang is living in Silicon valley where he works for Sun Microsystems in marketing. He recently celebrated his five-year anniversary. . . . **Ronald Tyler** is married to Suzanne Frick. He received his law degree from U.C. Berkeley in 1989 and is serving as an assistant federal public defender for the northern district of California.

I received a nice note from Dr. **Catherine Lisa Kauffman.** Lisa completed her residency in dermatology at the Washington Hospital Center. After passing the boards, she moved to the NIH National Cancer Institute where she does research and sees patients. Lisa is also pursuing a post-doc in immunological dermatology as well as working as a clinical instructor at George Washington University Medical School. She reports that two highly intelligent pooches guard her apartment while she sees patients and does research. Both Barney and Chloe have fine pedigrees. The latter, a victim of ichthyosis, collaborated on several research projects and conferences before agreeing to adoption. Lisa says that between work, dance classes, and dog chasing, life is never dull!

That's it for now, and probably for a while. At our ten-year reunion (one month from this writing) we will elect (draft) a Class Secretary to serve for the next five years. I am hopeful that one or more of you will volunteer for this honor! I want to thank all of you for your cooperation in providing me with good material. I look forward to reading the column and possibly writing it again sometime in the future. Although I often find myself writing this column late the night before it's due (reminds me of student days at MIT!), it really has been a pleasure! P.S.—Feel free to write to me, I will be happy to forward your cards and letters to my successor.—**Lynn Radlauer Lubell,** secretary, 2380 Northwest 41st St., Boca Raton, FL 33431

82 20th Reunion

There is no regular column for '82 this month, but we can add a few more details to the last issue's sad announcement of **Ted Baker**'s death from heart failure. In a letter to the *Review,* Ted's father noted his son's passion for physical activity. He enjoyed skiing, bicycle riding in the Oakland hills, mountain climbing, and weight lifting, among others. He was aware of his congenital heart defect all his life, but he didn't let it slow him down.

His father remembers how Ted loved MIT and the friends he made during his years as a resident of Burton House. And with only one day's notice, Marvin Baker reports, Ted's friends in California arranged a funeral on the Berkeley campus that was attended by 75 people.

Send your news to: **Stephanie Pollack,** secretary, 135 Sutherland Rd., Brighton, MA 02146

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I attended the lovely wedding of **Alan Taylor** and Leslie Maggy in Berkeley, Calif., on April 2, 1991. Classmates in attendance were **Jeff Muss, Kristin Foss, Ken Krugler, Mike Santullo, Chris Schneider, Brian Jacobs.** In fitting style, the weekend turned into quite a bash, featuring a card game called Boomba which Jeff Muss has proselytized up and down the West Coast. It's an easy game to pick up but a certain Lambda Chi (Jens '85) had more than his share of difficulty. However, I can assure you that neither peanut butter nor purple underwear had anything to do with it.

Chris Schneider recently announced his 30th birthday party in the Sierras which will have taken place by the time you read this. Better known as Tune-Master Schmedly, Chris organized the week-long birthday hike into three groups: the psychotic group, the healthy group, and the genteel (weenie) group. More details in the post-hike column.

Hyun-A Park, Michael Goldberger and **Paul Nahass** deserve kudos for putting together the "Going Out On Your Own" entrepreneurship conference held this past April at MIT. The event was sold out and featured a variety of alumni luminaries as speakers.

The following people wrote in while giving money to MIT: **Brian Pontius** was married on December 31, 1990, to Violette Paragas, and will graduate in June, 1991, with a PhD in biochemistry from Stanford. Brian's first paper has been published and he was awarded his first patent. . . . **Scott Leonard** was recently promoted to the position of program manager in Chevrolet Motor Division's International Programs Group. He is now responsible for program management and product planning for the Geo "Storm" car line. Scott says he travels to Japan frequently and often sees Lester Thurow at the Imperial Hotel. . . . **Ramin Khorram** has formed a company called Arkay Technologies, and was recently joined by classmate **Matt Dahl.** The company develops sound systems for personal computers, and recently expanded to larger offices in Londonderry, N.H. . . . **Ira Summer** writes that he has two sons, Theo, and Eric. . . . **Katherine Zebrose** writes that she and Don had their second son Cordell on January 11, 1991. . . . **Michael McConnell** writes that he is back in Boston after graduating from Stanford Medical School last year. He is now an intern in internal medicine at Brigham and Women's Hospital in Boston, and plans to continue there as a cardiology fellow. . . . **Roland Ouellette** is working at Digital and living in Acton, Mass. He just finished a master's in electrical engineering and computer architecture at the University of Illinois.

Please keep those cards and letters coming.—**Jonathan Goldstein,** secretary, TA Associates, 45 Milk St., Boston, MA 02109

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It's three months before our New Year's party and hopefully we will be in sunny Puerto Vallarta, Mexico for this year's party, organized by Roy Glikin, Brandeis '84. Roy is still working just across the street from the condo he bought. We thought for sure buying that place would cause him to change jobs or at least location. Here is the update from last year's party in Santa Cruz. Kelly, '86, and **Chris Craven** are still happy homeowners, cutting the grass, fighting airport noise, playing rugby and soccer, and trying to perfect superconductors. Denise, '87, and **Dennis Sacha** are still in Spain. Dennis may have been deployed in Desert Storm (but it is a secret if he was).

(John) Carl Adams is a graduate student again (at Stanford) but is having delusions of being President Adams. . . . **Oren Levine** actually made it in for the party from Israel. Oren has made Aliyah to Israel look like he will be calling Israel home. . . . **Eric Alani** and Esther "Es" Racoosin became engaged over the winter and should be tying the knot in October. . . . **Leif LaWhite** has moved back to good old Somerville, but makes it

PHOTO: L. BARRY HETHERINGTON

back to Vermont for a fair number of weekends.

Dave Walter is still at Boeing after six years, working on materials for the 777 (coming to an airport near you). Dave bought a house last January, an "L" shaped ranch not very far above the flood level of a river. . . . **Tony Riccobono** joins Dave with a consistency award for still being at Hughes Aircraft. Tony wishes all his friends a YARF! . . . **Gerard Palmeri** is working full time and going to school part time at Santa Clara University. By spring of '92 he hopes to have an MS in computer engineering. After graduating (and accumulating enough money) he hopes to travel the world for a bit.

Jeff Yoon has been traveling to the Far East for Advanced Micro Devices and took a vacation in Hong Kong. . . . **Paul Bradford** is still loving his software consulting job. . . . **Mike Landmeier's** truck broke down on the way up to Santa Cruz, but Mike made it, no shoes and all. Mike is still looking for the pot of gold on the other side of some cleverly connected ICs. . . . **Brett Hildebrand** and Jane Bednar are engaged (yes, to be married). In their spare time, they are buying all of Trump's distressed New York real estate.

Lori and I had the best tan at the New Year's party, having just come back from Aruba. Otherwise, the house eats our paychecks and time. Overall, I was surprised to find people did not have much to say in the New Year's notes (when I finally read them). Everyone was clearly having too good a time and was too stuffed on sushi to write.

Now, to the mail bag. **Suresh Subramanian** was promoted to district manager of Bellcore's software technology group. **Emi Lee** and her husband Suk, '82, are moving to California from Toronto. Their daughter Amanda was born in August 1990. . . . **David Karlin** is a senior test engineer for Freightliner Corp. His wife Hanna is now a dentist and they have two kids, 1 and 5.

Arthur Kinzinger is working at Draper Labs. He married Shari Tibbetts in September 1990. They honeymooned in Austria and Southern Germany, enjoyed an Oberammergau passion play, Oktoberfest, and more. . . . **Jerry Smith** has been working at GE Astro-Space Division in Valley Forge, Pa. While at GE, Jerry received an SM in systems engineering from University of Pennsylvania. He is going back to school full-time for a PhD at University of Colorado in Boulder. Jerry intends to research contamination of space habitats, skiing, hiking, and frisbee. . . . **Jeff Collett** and his wife Julie had a baby boy, Nathaniel James, in January 1991, born in Zurich where Jeff was completing a postdoc. In April, Jeff began as an assistant professor in environmental studies at University of Illinois at Urbana-Champaign.—From Bedrock, **Howard Reubenstein,** secretary, 28 Mitchell Grant Way, Bedford, MA 01730, (617) 275-0213 (home), hbr@mitre.org.

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Technology carries the day again. **Linda Sheehan** and **Roger Perkins** left an answering machine message to announce the birth of their son, Adam, on April 3, 1991. . . . Chris Monroe, '87, informs me via electronic mail that **David Wu** will marry Carys McDougall, a nurse from British Columbia. David is still tooling at Harvard B-School. They are planning a honeymoon in Portugal. Also, **Eric Liebeler** will marry Rene LaRoux. Eric is an attorney in the L.A. area, and Rene is originally a dancer from Montreal. . . . **Lee Brown** says that it has been a busy year. On June 2, 1990, he married Ema Dean, and two months later moved to San Francisco where he a took a job with Aion Corp., a knowledge base software vendor. Not content will all of this change, he and Ema recently bought a new house.

Gary Drlik is employed at GE Aircraft Engines outside Cincinnati where he is responsible for turbine clearance control on large commercial turbofans. Meanwhile he is preparing for the professional engineer exam, playing golf, tennis, running competitively, and enjoying Cincinnati's famous "Skyline Chili." . . . **Andrew Weiss** is running two companies which manufacture disposable vinyl medical supplies while preparing to marry his high school sweetheart in July 1991. . . . **Raymond Lizotte** is a senior environmental engineer at Texas Instruments Materials and Controls Group. He married Patricia Zeitler, '88, in July 1990. . . . **Wayne Townsend** moved back to the Boston area with his wife in spring 1990 after leaving the Air Force. He now lives in Quincy, Mass., and works for Andersen Consulting.

A reunion of sorts occurred at the home of yours truly during a party to celebrate my passing oral qualifying exams. Swimmers John Schmitz, '83, Bob Schoenlien, '84, Megan Smith, '86, and myself stood face to face for the first time in eight years. Also seen in the Bay Area was former swimmer and current Stanford graduate student Rebecca Perry, '86. Take it from me, they still look great!

Bask in the sunshine of unqualified contentment—send your QUALITY news to: **Bill Messner** , 520 Key Blvd., Richmond, CA 94805, (415) 237-3795, internet: messner%cmlds6@ucbarpa.berkeley.edu.

86

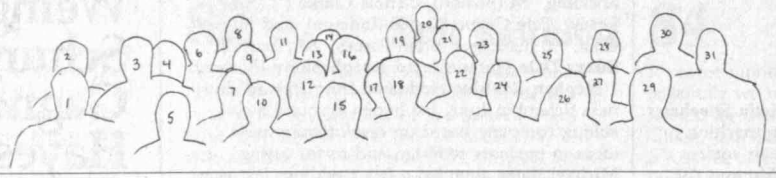
Dara Foias finished a master's in computer science at Stanford. . . . **John Bartholomew** and his wife Kim are expecting their first child, a boy, in early August. They're a little nervous about becoming parents but excited, too. . . . **Sharon Israel** graduated in May from Emory University with a law degree and an MBA. Starting in August, she'll be clerking for Judge Alan Lourie for two years on the U.S. Court of Appeals for the Federal Circuit in Washington, D.C. . . . **Tom Mueller** has two children, Elizabeth (2) and Matthew (7 months). Tom works at Bell Labs in Columbus, Ohio, where he's been a home owner since 1989. . . . **Mike Howard** graduated from University of Chicago Grad School of Business. He now works for Deloitte & Touche in Chicago as a senior consultant.

Linda van Duyne is living in Reading, Mass., with her husband Dan Ferguson, '85, and their one-year-old son Ethan. Linda works at EVS Engineering in Wakefield with Maryann Erickson, '84 and Rich Novo, '82. . . . **Rick Russell** played in the Beaver Cup II in February, the ice hockey game between Cal Tech and MIT Alumni. MIT won 2-0. California players included Rick, **Dale Archer, Ron Brisco,** Pat Foley (?), Marshall Jackson, '87, Scott Schwartz, '82, and John Weisbuch, '68. Out of towners included Mike Westphall, '90 (Boston), and Michelle Sequeira, '89, Heinrich Kockling, '84 (Boston), Dennis Clarke (?) (New Jersey), Pete Gasparini, '88 (Indiana), and Julie Choi, '90 (Chicago); Brian Forbes, '84 (Tucson); **Buzzy Dale** (Tucson); and **Joseph Shinn** (Boston).

Stephen Robbins graduated from Harvard Business School in June. He hopes to found a consulting company based on revolutionary new ideas in business redesign and restructuring. . . . **Michael Bates** attended a few weddings last year: Sam Lafontaine, '85, in Cleveland in June; **Sergio Ajuria** in Kansas City in August; **Stan Zygmunt** and **Melizza Ayuyao** in Chicago in October, and **Kerry Elkins** in Canton in December. He and his wife were in central Europe last September for several weeks: Bavaria, Prague, Vienna, Saltzburg, and Switzerland. . . . **Anthony Kolb** has lived in Thailand for four years with only occasional reminders of the Institute (a few visits from TDC frat brothers and a much delayed *Tech Review*). Recently, however, Anthony received a letter from the president of the MIT club of Thailand (Permanent Secretary, Ministry of Industry) which brings promise of new friends with familiar pasts. He recently married an enchanting Thai woman and drinks duty-free at the UN Environment Programme, and awaits visitors on their way through the land of smiles. . . . **Elaine**

At the June 1 wedding of Sarah Tabler, '85, and Christopher Lindblad, SM'89, ''something borrowed'' was no less than Sarah's wedding gown, loaned by friend Rosalind Picard, PhD '91. The Mead Chapel ceremony was performed by Sarah's father, minister of the Cedarville Presbyterian Church in Cedarville, N.J. Sarah received her MBA from Harvard a few days after the wedding; this year she completes her five-year term as a member of the MIT Corporation. Christopher is a PhD candidate in the Laboratory for Computer Science. A July honeymoon in Hawaii was planned to see the total solar eclipse.

MIT participants were: (1.)Andre Tchelistcheff, SM '90 (2.)Sarah McCord Nabee, '85 (3.)Greg Arenson, '70 (4.)Robin Johnson Jeffries, '85 (5.)Karen Arenson, '70 (6.)Marc Johnston, '84, SM '89 (7.)Damaris Ayuso Planes, '84, SM '85 (8.)John Wroclawski, '78, SM '84 (9.)Stella Hetelekidis, '84 (10.)Maria Elena Lara, '84 (11.)Jean-Pierre Schott, SM '82, PhD '89 (12.)Lisa Tener, '84 (13.)Corine Bickley, PhD '87 (14.)Karen Sollins, SM '80, PhD '85 (15.)Sara Tabler (16.)Anita Flynn, '83, SM '85 (17.)Hyun-A Park, '83 (18.)Chris Lindblad (19.)Bernard Loyd, '85, SM '85, PhD '89 (20.)Greg Troxel, '87, SM '90 (21.)Christian Matthew, '43 (22.)Jennifer Lund, '89 (23.)Jacob Friis, SM '90 (24.)Anita Killian, '85, SM '87 (25.)John Kimble, '91 (26.)Deborah Howe, '84 (27.)Ellen Hildreth, '77, SM '80, PhD '83 (28.)Eric Grimson, PhD '80 (29.)Christos Kaklamanis, '86 (30.)Gerald Roylance, '75, SM '80, PhD '90 (31.)Thomas Knight, '79, SM '79, PhD '83



Wu became Elaine W. Stephenson on April 21, 1990. Several pikans and Chorallaries were in attendance. . . . **David Martin** got married in June 1990 to Whitney Buss. They spent their honeymoon in Jamaica and now reside in Redwood City, Calif. Dave was recently promoted to vice-president of strategic marketing at Oracle. This is a new organization for Oracle, so the position should be exciting and challenging. . . . **Jim Prusko** is a first-year MBA student at Tuck (Dartmouth). He'll be working at Solomon Bros. as a bond trader in New York City this summer. . . . **John Campbell** is working for Exxon in Houston. . . . **Ray Brunsberg** is working for Solvay & Cie in Sarralbe, France. . . . **Lo-Ping Yeh** is a 2nd-year MBA student at Harvard and will be working at McKinsey in Boston next year.

Simone Pottenger has been working for Boeing in the Commercial Airplane Group for the last five years. Her current project involves the design and implementation of an avionics databus architecture for the 777, Boeing's newest plane. The first flight will be in 1994 and there's plenty to do to keep her busy between then and now. . . . **Ron Bloom, Wally Santarelli,** Julie Wolf, '85, and Edie Erlinson, '87, also work there. I recently talked to Ron. He's in the autopilot group for the 777 and Wally is in the flight controls group. . . . **Betsy Salkind** starred in "She Who Laughs, Lasts" in March at the Blackman Auditorium at Northeastern University. . . . **Dave Milli** moved back to his home state of Ohio in February 1990 to work for a slipper manufacturer. He now works for Banc One Services in Westerville, Ohio. His responsibilities as a business systems analyst include development of an international system, installation of the system at Dayton, Milwaukee, Cleveland, and Indianapolis, and production support.

I finally tracked down **Tom Paterson.** He works for GTE in Mountain View (or Sunnyvale; that area, anyway). However, this summer, Tom will start work toward a PhD at Stanford in the engineering economic systems department, concentrating on artificial intelligence. . . . **Yona Kaplan** still works for EDS in Michigan. She's a manufacturing consultant which means she goes to companies and tries to help them improve their quality. . . . **Carolyn Beer** aka Carolyn Zerkle, finished a master's in architecture and business at University of Illinois. Last October, she married

PHOTO: PAUL LINDBLAD

Dave Zerkle and as of April, was three months pregnant. Congratulations! She now works as the State Architect for Illinois State University. . . . **Steve Brandwein,** along with **Rod DeBiase,** is doing a residency at Boston University in internal medicine. Steve, however, is transferring to University of Alabama at the end of June. . . . **Alan Hildebrand** got married in August 1990 to a first-year law student. Alan is in Michigan doing an orthopedics residency at University of Michigan. . . . **Dennis Cuy** and Sarah Danca are getting married in November in Boston. Both work for McDonnell Douglas in Huntington Beach, Calif. . . . Other news is that **Lenny Tender** is still married.

A word of advice for those considering marriage to a tall man (or woman). Buy your dream car before you get married. Erik and I test drove the Mazda Miata and Erik, at 6'6", doesn't quite fit (without the use of a shoe horn). So, alas, I'll have to wait until I can afford a large convertible. Until next month.—**Mary C. Engebreth,** secretary, 1805 Manhattan Ave., Hermosa Beach, CA 90254, (213) 376-8094

87 5th Reunion

Hello again. Special thanks go to **Chuck Davis** for writing me from Kuwait. We're all glad that things went so well and we greatly appreciate your service to the United States! Chuck's March 20 letter was so interesting that I'm printing it in its entirety: "I deployed to Saudi with the 3rd Armored Division on December 27. We spent some time at King Kahlid Military City, then moved out into the desert. After we attacked on February 24, we ended up fighting the Republican Guard "Tawakana" Division, a heavy mechanized unit. (Tawakana", I'm told, means "Go With God.") We trashed them, then fought our way into Kuwait fighting two more armored divisions. Since the cease fire we've been sitting in Kuwait destroying all the vehicles and ammunition the Iraqi's left behind. We've got thousands of square kilometers of destroyed tanks, APC, trucks, etc. with multi thousands of bunkers, not to mention unexploded ordnance lying everwhere.

"My division, the 3rd Armored Division, lost seven killed against the Iraqis, but by my own count, a majority of that was from simply being in a dangerous environment, rather than from actual enemy fire. As an example, a soldier sees what looks like a softball and picks it up. It's actually an unexploded submunition from an Air Force Cluster bomb (a dud). It goes off in his hand and kills him. The Iraqis actually killed few Americans. Curiosity killed a lot.

"The Iraqis did a number on Kuwait. They destroyed just about everything in the country; it's awesome. I've been through several bad hurricanes (not like Gloria in Boston, real hurricanes) and I've never seen anything close. Our sky is lit up by oil wells they set on fire. There are so many, it'll take almost two years to get them all out. Theyre so hot you can't get within a half mile of them. When the wind blows the smoke over us, it blots out the sun and the temperature drops 20 degrees F. It's a miniature nuclear winter. I was flying yesterday and my helicopter ran into the smoke. It was a sheer wall of black from ground to 4,000 feet, and stretched each way as far as we could see.

"It was so dense, we had to turn the copter around even though it was an all weather aircraft. Really, I just can't describe the destruction the Iraqis did, most of it absolutely without reason. And now, they're showing much more willingness to fight against their own civilians than they ever did against us. The general feeling here toward the Iraqi leadership (but not the individual solders so much) is rather unprintable.

"I don't know of anyone else over here. **Rocky Moy** has deactivated his unit in Germany, and I hope to be back to Ft. Benning, Ga., for the Infantry Officers Advanced Course in late July.

"Also, if you want to mention it, in addition to the "Desert Storm" participation ribbon everyone here gets, I also was awarded a Bronze Star." CONGRATULATIONS ON THE BRONZE STAR!

I also got some information from the *Technology Review* office: **P. Sue Mundell** was recently promoted to senior assistant to the editor, *Handbook of Latin American Studies,* an annual annotated bibliography covering the humanities and social sciences. . . . Lt. **Andrew Sterbenz** has a new job: Executive Officer for D Company, 31st Engineer Battalion, Ft. Leonard Wood, Mo. He is training new soldiers to become combat engineers. . . . **Sun Choi** and Charles Hong, '88 will be getting married on June 15, 1991. Sun is working at Logica. Charles is currently an MD/PhD student at Yale University. Sun will join Charles in New Haven after June 26, 1991.

Warren Katz started a small computer company called Mak Technologies. The company is involved in Distributed Simulation Technology. . . . **Michael Donohue** is "living large in California with or nearby fellow Fiji's **Aurelio Peccei,** Lyle Tripp, **Carlos Ferreira, George Zachary,** Rich Rice, and Gordy Holterman." Mike is enjoying his new 750cc Sazuki Intruder and flying the OH-58 helicopter for the CAANG. . . . Alright, gang, now it's your turn. Send in those letters!—**Stephanie Levin,** secretary, 393 West End Ave., Apt. 8B, New York, NY 10024, (212) 595-3172

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Hello everyone! Hope your summers were good! I guess I should probably stop considering "summer" as a entity separate from the other seasons. After all, it's business as usual for the majority of you, right? It's hard to keep things in perspective when you're a perpetual student, like some of us. I'm looking forward to fourth year of medical school, but it's once again application time. . . . every four years without fail!

Howard Tam writes from St. Paul, Minn. He is an advanced product development engineer at 3M, conducting research in the areas of extrusion and polymeric materials for film products. Since he started working full-time, he has had the opportunity to travel extensively—including France, Italy, Spain, and the Netherlands. How wonderful! He also plays rugby and serves as a member of the MIT Educational Council, interviewing prospective high school students for MIT. Howard had a chance to visit **Alan Sbarra,** who lives in an apartment overlooking Lake Michigan and is employed at United Airlines. Alan enjoys the travel benefits associated with his work.

John Kuenzig works as a product marketing manager for Boston Technology in Wakefield, Mass. He was recently engaged to Sonia Leon, '87, to be married in September 1991. . . . Wedding bells are also ringing for **Charles Hong,** who married Sun Choi, '87, in June. Congratulations to both couples! Charles received a research fellowship in the cardiac unit at Yale Med after his first year of medical school. He enjoyed research so much that he is back at Yale going for a PhD in molecular biology. He says he hopes to go back to med school eventually.

Mark Schudt is still at Los Angeles Air Force Base "working hard to make SDI work." . . . **George Fitzmaurice** works at the Institute for Research in Information and Scholarship at Brown University. He is also working towards a master's in computer science at Brown. . . . **Michelle Sarin** completed a master's in statistics at Wharton last May. She is working as a biostatistician for Harvard Medical School's Department of Health Care Policy. . . . **Chiu Jeng** works for First Boston in New York City. He will be hanging out with Basil Ma ('86, and no, not any relation of mine) and anticipating a blast of a good time!"

Juan Cornejo graduated from Harvard's JFK School of Government with a master's in public policy last June. He will spend a year at UC Berkeley's Law School and receive a JD in June 1992. He plans to return to his Northern California roots and to work for the state government or for a private law firm doing administrative law. He relates that **Hans Lee** got married in July 1991 in New York City, with many Delts in attendance. That's all folks! Keep those letters coming. New address: **Grace Ma,** secretary, 545 1st Ave., #7R, New York, NY 10016

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Thanks to some last minute e-mail, there is some news to report. I was getting worried though! **Ross Snyder** is in the second year of law school at the University of Southern California in Los Angeles. Ross is spending the summer working at a patent law firm in L.A. . . . **Andrew Good** works for ComFed Savings Bank as an AVP. Since December 14th, he has experienced the savings and loan crisis personally, as ComFed was seized by the government. Andrew is considering business school as a way to ride out the recession. . . . **Russell Boten** has completed naval nuclear power training. He will be going to SWOS in Coronada, Calif., then will be assigned to the *USS Long Beach.* . . . **Anthony Lombardo** is making plans to marry to Kristy Robinson. . . . **David Blackston** has finished his second year in computer science at Berkeley. David has been following a number of local bands and has been enjoying himself immensely. . . . Air Force 2nd Lt. **Jeffrey Schwelfer** has been named Company Grade Officer of the year. Jeffrey is command and control engineer at Lindsey Air Station in Wiesbaden, West Germany, where he has been since the Berlin wall came down. Jeffrey anticipates a new assignment in November.

Since graduating, **Eliot Levine** has spent a year traveling, mostly in Israel. Eliot worked on a kibbutz for four months, and also studied at an orthodox Jewish school in Jerusalem, as well as at an institute for Buddhist studies in England. Since returning from his travels in 1990, Eliot has been working on two drug treatment and prevention programs in Cambridge—a cocaine addict treatment project, and a substance abuse prevention plan for Rhode Island. He has been working with affiliates of the Harvard School of Public Health and the Cambridge Hospital, and is preparing to apply to programs in clinical psychology. . . . **Dave Duis** has been teaching diving to disabled divers in Monterey. Dave was recruiting at MIT in the spring for Silicon Graphics, the only recruiting team wearing jeans. (He wants the recruits to be less nervous!) Dave invites anyone in the area to drop by. (Remember, you can call Alumni records at 617-253-8270 for the addresses of any class members, or to change your address.) . . . **Dean Chang** writes that he received a master's degree from Stanford this past year. Dean also is the recipient of an Air Force Fellowship, and will spend another three years working on a PhD. Dean writes, "I'm enjoying life here. I just went to take in a Stanford baseball game today. The team's pretty good, but most people go to lay out on the grass along the third base line to get some sun." Dean has also been taking classes in windsurfing, Chinese, and digital control. . . . Dean has been attending various parties, and among those he saw at Julie Wissink's ('90) party were Terry Olkin, '88, Cathy Sybert,'88, **Sayan Chakaborty,** Chris Racicot, '88, Denis Gulsen, '88, Billo Naravene, '90, Rick Marks, '90, Walter Chung, '90, Laura Fleming, '90, Beth Kulas, '90, **Steve Malinak,** and **Sam Druker.** . . . **Angeli Salgado** also had a party, where I saw **Steve Malinak,** Dave Maes, '87, **Ron Koo, Joe Lichy, Bill Maney, John Flight, Rosanne Park,** Laura Scolnik, '90, Dan Mittleman, '88, **Elizabeth Greyber,** and Megan Smith, '88.

Erik Ordentlich has gotten engaged to Pau-Hua Kuo, '88. . . . **Alice Mendelsohn** is finishing up her coursework in materials science at Northwestern, but still has a while to go for a PhD. Alice has been busy this past year with intramural floor hockey and volleyball. Alice reports that "Northwestern has its own beach so

summers around here are actually pretty fun." Alice wrote that one day "when I was wearing my MIT Field Hockey jacket, someone stopped me to ask if it was a 'real' MIT jacket. I said it was, expecting a typical Big 10er lecture on 'real' sports schools, and this guy proceeded to congratulate me on getting in and graduating. Has this kind of thing ever happened to anyone else?" . . . **Andrew Yee** is also at Northwestern. . . . **Sandy DeVincent** just finished a master's in materials science at Case Western and will be continuing on for a PhD. She and her husband Tom Moynihan (from WPI) just bought a house in the Cleveland area. **Mark Lubratt** is at MIT hoping to finish a master's in mechanical engineering this spring and has travel plans to California, Japan, Texas, and Florida over the summer.

Marc Itzkowitz works for GM in Detroit and lives in Ann Arbor. . . . **Howie Zolla** was recently studying for his qualifier in applied physics at Harvard. He's going to be a floor tutor next year so he may have positive cash flow. . . . **Jeff Killian** is stationed in Bremerton, Wash., at one of the submarine shipyards. Jeff plans to get married in November. . . . **Lori Aronson** was married to **Mark Andersen** on June 16th. **Jeff Alexander, Carlos Barreto, Lori Tsuruda, Laura (Ryzowicz) Rapacioli,** and Jocylyn Bailin (Wellesley '89) were in the wedding party. Lori reports that "life here is Cleveland is pretty bland, although busy, as I get ready to start my third year of medical school in July (clerkships on the wards) and finish wedding plans. Boy, will I be glad to end this year! After this, I will not have to take any more classes for a very long, long time! And then there will only be one more year here before Mark and I return to Boston (yay!)." . . . **Teri Centner** writes to report that **Kyle Robinson** will be flying B-1s. **Mike Fincke** is trying to get to Edwards AFB to be a Flight Test Engineer. Teri was recently visiting Boston over the Patriots Day weekend. . . . **Mike Berube** was quoted in the April 29 issue of *US News and World Report* in an article on social engineering which was part of the annual best graduate schools issue. Mike, who is in the Technology and Policy Program at MIT, was described as "one of thousands of engineering students who are broadening their skills through interdisciplinary graduate programs that incorporate business management, environmental studies, and policy analysis into technical training." The article continued to say that "engineers with Berube's expertise will be in high demand." Mike and **Alan Davidson,** were co-captains of the TPP Johnson Games Team, the "Socially Concious Attack Engineers."

At the end of the summer, I will be moving to Senior House, where I will be a floor tutor. I will include my new address in an upcoming issue. Don't be afraid to write to this address, though! Please send some news of summer adventures!—**Henry Houh,** secretary, 14 St. Paul St. #1, Cambridge, MA 02139, (617) 661-1691, e-mail: tripleh@athena.mit.edu

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Sandy Serkes is working in Cambridge for Arthur D. Little. She'll be travelling to Europe this summer with **Aaron Goodisman.** On a recent trip to Washington, D.C., Sandy saw **Lori Brown.** Lori is working for E-Systems and living in Falls Church, Va. . . . Congratulations to **Martine Osias.** Martine has just been promoted to the position of principal investigator at Aspen Technology Inc. in Cambridge. As principal investigator, Martine will be working on a three-year project developing a coal cleaning simulator for the U.S. Department of Energy. . . . Also working in the Boston area is **Peter Gordon.** Peter is working as a patent engineer for Wolf, Greenfield & Sacks, an intellectual property firm in downtown Boston. In the fall, Peter will be attending Suffolk University Law School. . . . **Flora Feng** writes from Sewell, N.J., that she's been working for Mobil Research and Development Corp. She's doing research in the diesel fuels group. Outside of work, Flora has been an educational counselor for MIT, interviewing students for admission. She has also just completed a training course in literacy tutoring and will hopefully be getting a student soon.

Some news from the Midwest. **Lesley Redman** write that she's been studying patent law at IIT Chicago-Kent College of Law. . . . Also out in the Chicago area is **Giselle Mosnaim.** Giselle is working for an MD and master's in Public Health at the University of Illinois at Chicago. . . . **Stacy Segal** has just landed an internship with Healtheast, the largest multi-hospital system in Pennsylvania. She'll be soon moving to Allentown to start her internship. . . . When I was out in Michigan for a short vacation, I met up with **Steven Shen** and **Amos Leung.** Amos, who works in the Detroit area, is currently on a temporary assignment at Ford's Boston district sales office. He was just back in town for a couple of days. Steve mentioned that while he was in London on vacation, he saw **George Nunn** and **Roberto Hoornweg.** George and Roberto are sharing a flat in Kensington.

Out on the west coast, **Joanne Spetz** is pursuing a PhD in economics at Stanford and loving the sunny weather out there. Joanne also brings us news of **Joe Babiec.** Joe seems to be having a lot of fun in London, going to the theater, meeting the Queen, and skiing in the mountains near Spain. Joe is in London on the Marshall Scholarship. . . . How's everyone spending their summer vacations? Send news to **Ning Peng,** secretary, 409 Argyle, Mineola, NY 11501, (212) 745-2704

COURSE NEWS

I CIVIL ENGINEERING

Garrett L. Dietz, SM '76, writes: "I recently returned from Sydney, Australia, to head the New York office of Cresap, a Towers Perrin Company. Cresap provides general management consulting services to oil and gas, utility, transportation, chemical, publishing, media, financial services, and other industries throughout the world." Dietz is the company's VP and manager. . . . **David N. Deleeuw**, SM '81, reports: "I am currently managing the Civil Engineering Department for the Jackson, Mississippi, office of Michael Baker, Jr., Inc., consulting engineers. I was selected as the Outstanding Young Civil Engineer in 1991 for the State of Mississippi." . . . Colonel **Charles Thomas**, CE '72, sends word: "I am serving as Los Angeles district engineer with the U.S. Army Corps of Engineers. I am leaving a 1,000-member organization responsible for civil and military construction in Southern California, Arizona, and the southern third of Nevada." . . . **Anne Carey**, SM '86, writes: "I left Cambridge last summer for the wilds of Nevada. I am working on a PhD in hydrology at the University of Nevada at Reno."

Chris Bailey, SM '90, writes: "I'm in the Pittsburgh area working for an E.N.R. top geotechnical specialty contractor, Geo-Con, Inc. The president of Geo-Con is **Christopher Ryan**, '69." . . . **Robin K. McGuire**, '68, has been elected president of the Seismological Society of America for 1991-92. He continues in his position as president of Risk Engineering, Inc., in Golden, Colo. . . . **M. David Egan**, SM '66, has been named an Honorary Member of the American Institute of Architects. Honorary Membership is the highest honor the institute can bestow on a person outside the profession of architecture. Election is voted to recognize truly significant and distinguished contributions to architecture. The AIA jury commented: "Professor M. David Egan, a leading authority on architectural acoustics and author of five books, has promoted a better understanding of the crucial relationship between building systems design and technical theory, and has motivated hundreds of students and professionals to achieve design excellence. "

William T. Lang, SM '57, of Winchester, Mass., died on December 29, 1990. Lang worked for the Bates Manufacturing Co. in Augusta, Maine. During his years at Bates, he rose to serve as head of the company's experimental division, headquartered in Lewiston, Maine. During World War II, he entered the Navy, rose to the rank of lieutenant, and was assigned to the headquarters of the Pacific fleet in San Francisco. In the mid-1950s Lang decided to switch careers and entered MIT. Over the next 26 years he worked for a number of engineering firms in the Boston area including Charles T. Main, Inc., which he joined in 1974 and from which he retired in 1983. During his career he was involved in the design of both public buildings and hydro-electric projects. Structures he worked on include Lincoln Labs, the Boston University School of Law, Boston English High School, and the original Burlington Mall, as well as a major renovation for the old Statler Hilton, which is now the Park Plaza in Boston. Among the hydro-electric projects he worked on were the massive Shiroro Dam in Nigeria, and a number of smaller dams in New York and northern New England. Following his retirement he was involved in several architectural renovation projects and found time to pursue his interests in linguistics, physical science, investing, and wine making.

II MECHANICAL ENGINEERING

Peter Kalustian, SM '34, sends word from Boonton, N.J.: "Well, the downhill ski season is over as of May 1st, and this has meant 66 days of skiing this season, mostly in the New Jersey hills, New York state, Vermont, and one fine week in Whistler-Blackcomb in British Columbia. My ski clubs are the 70+ and High Life, along with my other skiing pals. I shall continue my skiing as long as my health holds up and I still have the desire to do so. I hit 80 years on May 21st, but don't feel old. Obviously my health continues very good. A cataract removal and lens replacement in my right eye a year ago has been quite a help. As far as my international consulting business in the food fats and derivatives processing is concerned, it still continues with some curtailment at the moment. Some of my clients are in Australia, Italy, Mexico, and of course, in the U.S. I keep real close to my two children and their spouses and families, which includes my two grandchildren: Karl, 17, and Clare Marie, 16, who live next door with my daughter and her husband. Karl is preparing to go to an engineering college in the fall of 1992. Regards to all my classmates." . . . **Gerald A. Frederiksen**, SM '59, reports: "I have retired, built a new home in Florida, and after six months of loafing, have been retained by the Port Charlotte United Methodist Church as director of music. My wife, Gloria, is organist, and together we are leading five choirs and two handbell choirs—end of retirement!"

Serope Kalpakjian, SM '53, writes: "As chair of the Illinois Institute of Technology Faculty Senate, I represented the faculty in my welcoming remarks during the inauguration of IIT's new president, Lewis M. Collens." . . . John J. Moskwa, PhD '88, writes that he is chair of ASME's Transportation Panel in the Dynamic Systems & Controls Division. . . . **Paul F. Swenson**, SM '63, sends word from Cleveland: "I was elected a Fellow by the American Society of Mechanical Engineers last February. Cited were 12 patents related to fuel-fired heat pumps, cogeneration, and natural gas vehicles. I am currently chair of the standards committee at NGVC; coordinating development of a family of standards for natural gas vehicles and related fueling connectors, fuel containers, and fueling stations." . . . **Howard A. Leibowitz**, '63, has joined the Nabisco Biscuit Co. as VP for engineering and operations planning. Leibowitz had been VP and COO of Grant Industries in West Nyack, N.Y., from 1988 until joining Nabisco. . . . **John Psarouthakis**, '57, was honored with the 1990 Academy of Achievement Award in the field of Business and Commerce at the Ahepa Educational Foundation's Annual Banquet. Psarouthakis is the founder, chair, and president of J.P. Industries, a manufacturer of transportation components with sales reportedly exceeding $400 million. He has lectured and received numerous awards and invitations around the world. He has published articles on topics ranging from plasma, surface and solid state physics, direct energy conversion, metal forming, and electrical transmission to management. In 1989, he published a book entitled *Better Makes Us Best*.

Bharat Bhushan, SM '71, a senior engineering manager at IBM's Almaden Research Center in San Jose, Calif., received an ScD from the University of Trondheim, Norway, recently. . . . MIT Professor **Joseph L. Smith, Jr.**, ScD '59, has been appointed a Ford Professor of Engineering. The Ford Professorships in Engineering—there are seven at MIT—were endowed by the Ford Foundation in 1960 to recognize outstanding senior faculty in the School of Engineering for intellectual accomplishment, innovation, and leadership. Smith, a member of the Department of Mechanical Engineering, is widely respected for his work in cryogenic engineering and the application of superconductors. His work combines the fundamental sciences of heat transfer, cryogenics, thermodynamics, and electromagnetics. He is noted for his ability to develop innovative technologies and implement and demonstrate them in engineering prototypes. Smith has been a leader in developing the undergraduate core subject in thermodynamics and in the development and implementation of computer-aided techniques to assist students in learning thermodynamic principles. Since 1964 he has been in charge of the MIT Cryogenic Engineering Laboratory.

James R. Wynne, SM '53, of Miami, Fla., died on December 21, 1990. Wynne, who created the first successful inboard/outboard powerboat

drive, was a dedicated engineer and boat racer. Renowned for inventing the stern drive used in millions of boats, Wynne also helped to refine the deep-V hulls used in high-speed, offshore boats. Early in his career he worked for the Kiekhaefer Corp., which built Mercury outboard engines. After becoming head test engineer at their R&D base, he left the company in 1957 to work on the stern drive. Wynne engineered the invention in the garage of his family's Miami home. In addition to his other interests, Wynne was also an adventurer. In 1958, he and another man sailed the Atlantic from Copenhagen to New York in an outboard boat. Using racing to test his inventions, Wynne ended up winning many of the world's major races. In addition to being a skindiver and writer, he was used as an expert witness in a number of cases that involved boating. . . . **Robert William Morgan**, SM '38, of Denver, Colo., died on January 19, 1991. There was no further information provided.

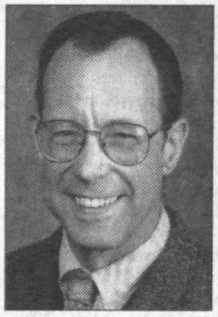
III MATERIALS SCIENCE AND ENGINEERING

Tom Clevenger, ScD '61, writes: "I returned from 10 years in Japan last August and have started a consulting operation, TRC Associates, based in Akron, Ohio. It was hard to leave Tokyo and my successful consulting operation, but all good things come to an end. I'm enjoying rediscovering America!" . . . **Richard Krueger**, SM '90, reports: "I am currently a program manager at Digital, working on DEC's sourcing strategy, marketing analysis, technology transfers, and technology management." . . . **Douglas W. Fuerstenau**, ScD '53, who holds the P. Malozemoff Chair in Mineral Engineering in the Department of Materials Science and Mineral Engineering at the University of California at Berkeley, has been named the first recipient of the Frank F. Aplan (ScD '57) Award for the Engineering Foundation. Fuerstenau was cited for "his unparalleled theoretical accomplishments in mineral benefication processes, particularly flotation, comminution and agglomeration." In 1989, the Engineering Foundation of the United Engineering Trustees established the award in honor of one of its long-term chairs who had pursued a life-long career in coal and mineral processing research and education. This award was established "to recognize engineering or scientific contributions that further the understanding of the technology of coal and/or mineral processing."

IV ARCHITECTURE

Vladimir "Walter" Dackiw, SM '85, writes: "I married **Susane Havelka**, '86, and we live in NYC. I have worked for Tishman Speyer Properties, a international real estate development firm based in NYC. Susane got her masters in architecture from Columbia University in 1989. She has worked in Osaka and Toronto and now in NYC, as an architect." . . . **Nicholas Harris**, MAR '82, sends word from Sacramento, Calif.: "I am manager of the Architecture Department at First Nationwide Bank. Monica and I have three children: Rebecca, 9; Kathleen, 5: and Peter, 3." . . . From Duxbury, Mass., **Alex L. Seid**, MAA '74, reports : "I spent last summer participating in an Asian field seminar/MBA course with Boston University. I visited Japan, Korea, Thailand, and Hong Kong, and met with several Course IV alumni/ae. In Bangkok I saw **Philippe E.G.T. Annez**, MAR '71, who is regional director at the World Bank in Thailand. I missed **Earl Kessler**, MAR '71, who was on leave from his job as a US AID officer." . . . **Demetrios A. Criezis**, MAA '77, and his wife **Susan Schneider-Criezis**, MAA '78, have open a new firm: Criezis Architects, Inc., located in Evanston, Ill. They have a staff of 17 handling architecture and interiors. . . . **Edgar C. Rust III**, MCP '63, is "publishing *Music For The Love Of It*, a monthly newsletter for amateur musicians." . . . **Mindy B. Lehrman Cameron**, MAR '82, sends word from New York City: "I'm running my own architectural firm and currently working on an extensive exhibition about recycling, etc. I married Max Cameron in May 90."

Ellen Shoshkes, MAR '77, reports: "I am director of housing research within the Architecture and Building Science Group at New Jersey Institute of Technology, of which **Ezra Ehrenkrantz**, '54, is chair. I recently completed an evaluation of New Jersey's subsidy program for low and moderate income housing, through the analysis of 25 case studies of new construction and rehab projects. The National Endowment for the Arts has awarded grant funds to support further research using these case studies, as well as other examples, to develop guidelines for incorporating quality design in affordable housing, in a way that public officials, developers, builders, and community groups can understand and use. The State of New Jersey will distribute this report." . . . **Herbert G. Zeller**, MAR '67, is VP at Camp Dresser & McKee, Inc. Previously, he was an associate with the Cambridge-based firm. . . . **Erin R. O'Boyle**, SM '85, is VP for Portfolio Management at The Beacon Companies in Boston. . . . **Robert J. Thrasher**, SM '65, has been named executive VP and COO at the New York Telephone Co. in New York. Thrasher had been the company's general manager. . . . **William L. Rawn III**, MAR '79, has been named a trustee at Bennington College in Bennington, Vt. He will continue as principal of William Rawn Associates in Boston.



H.B. Zinter

Herman B. Zinter, MAR '66, has been named as a principal in the firm of Rothman Rothman Heineman Architects, Inc., in Boston. He has been with the firm since 1981 and has served as an associate for the past eight years. According to a company press release, "Herman is highly regarded for his design leadership and management of the firm's projects at Boston's Beth Israel Hospital. His designs for major medical facilities are represented throughout Beth Israel as well as at the Veterans' Administration Medical Center in Togus, Maine. Herman's work involves program development, architectural design, feasibility studies, and building systems analysis. He is expert in his speciality and has made significant contributions to the firm's successful growth." . . . *Wasting Away: An Exploration of Waste: What it is, How it Happens, Why We Fear it, How to Do it Well* (Sierra Club Books, 1991), is a new book by **Kevin Lynch**, '47, edited by Michael Southworth, PhD '70 (XI). According to a book release, "Lynch, who died in 1984 as this book was nearing completion, was a noted urban designer and professor of city planning at MIT for more than 30 years. A student of Frank Lloyd Wright at Taliesin, his design projects included work on Boston's waterfront and the University Circle area of Cleveland. The recipient of many professional honors, he was also the author of eight books, including his classic *The Image of The City*. Southworth, a student and colleague of Lynch, finished preparing the manuscript of *Wasting Away* for publication and contributed the photographic essay, 'Looking At Waste.' He is an associate professor of urban design and environmental planning at the University of California at Berkeley."

George E. Kostritsky, MCP '51, announces, with great regret, the passing of his wife Penny, on January 5, 1991. Kostritsky also wished to announce that the family has established a memorial fund in her name, The Penny Kostritsky Memorial Fund at Sheppard Pratt, a Baltimore, Md.-based not-for-profit health system. The fund has been created to help financially needy families with chronically mentally ill children or chronically mentally ill adults without family support to obtain the services which are offered through Sheppard Pratt's Life Care Case Management Program. The program is envisioned as a comprehensive system of services which may be arranged and funded in advance by families wishing to provide for the future care and treatment needs of their family members with chronic mental illness. Such advanced arrangement would be made for the time when the family is no longer able to be actively involved in the management and/or selection of needed services.

V CHEMISTRY

Thomas R.P. Gibb, PhD '40, writes: "I am still moderately active professionally at 75 and looking forward to resuming tennis. I bought a 1989 Alumni/ae Directory to replace the worn-out 1948 one. One of the rewards of teaching is letters and cards from former students. Some of mine are now retired also! I joined the MIT Course V faculty in 1940—am I the only survivor?" . . . **Dabney White Dixon**, PhD '76, reports: "I am now an associate professor of chemistry at Georgia State University in Atlanta, Ga. Research continues on biological electron transfer as well as porphyrins and related macrocycles as antiviral agents." . . . **Elbert C. Herrick**, PhD '49, writes: "I retired from the Mitre Corp. in 1988, from Dynamac Corp. in 1989, and I intend to incorporate in 1991 as ECH Sciences, Inc., to consult in chemistry and chemical engineering." . . . **Mark L. Shannon**, PhD '80, is a senior research scientist for Vista Chemical Co.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Kenzo Kobayashi, who did advanced studies in EECS in 1971 writes: "After 23 years from the graduation at Tokyo University in Japan, and 18 years from MIT, I'm working as a manager of a large manufacturing company that makes all kinds of electrical and electronic machineries. The experience at MIT is still alive in my mind and will always remind me of the newest and hardest works in my business fields. I want to say thanks to all the folks in the U.S. of 17 years ago, when they gave me best chances to challenge the new educational activities. I think we Japanese should owe to you, MIT, and want to do anything which we can do. Best wishes to your country and university." . . . **Kevin Parker**, PhD '81, reports: "I have been appointed director of the Center for Biomedical Ultrasound at the University of Rochester. I am an associate professor of electrical engineering and radiology. The center brings together researchers in diagnostic and therapeutic aspects of medical ultrasound from departments in the U of R Engineering College, School of Medicine, and College of Arts and Sciences." . . . **Jeffrey D. Abramowitz**, SM '85, writes: "I received an MBA from Stanford in December 1990 and am now working for Domestic Automation Co. in San Carlos, Calif."

The International Federation for Information Processing has given the 1991 Namur Award to **Joseph Weizenbaum**, EECS professor emeritus and senior lecturer at MIT. The Namur Award, established in 1989, is made biennially for "an outstanding contribution to the creation of awareness of the social implications of information technology." According to an IFIP press release, "For

BY DAVID ANDREWS, '66

1920–1991

John Elliott
Art, Science, and Alchemy

Professor John Elliott, ScD '49, died April 15, 1991, at the age of 70. He was the American Iron & Steel Institute Professor in the Department of Materials Science and Engineering and director of the Mining and Mineral Resources Research Institute.

I met John Elliott twice. The first time was at a symposium in his honor at MIT last summer (the International Symposium on Chemical Process Metallurgy, June 10–13, 1990). If I found the talks scholarly and dry, I did get a better feel for the metal-making science in a more informal setting. All the attendees signed on for a celebratory dinner in the Tapestry Room at the Museum of Fine Arts. I chose a seat at one of the tables and introduced myself as a science writer. An Australian at the table hooted with laughter—"You're in the wrong place, mate," he merrily observed. "This isn't science!"

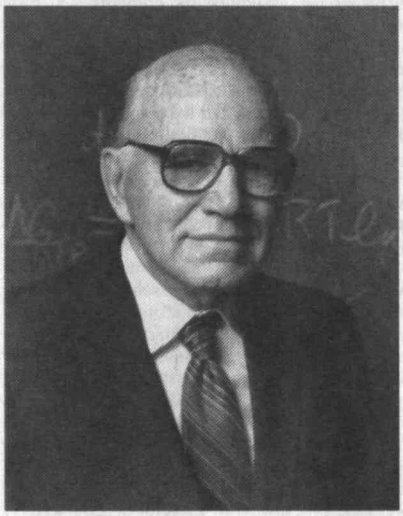
In a way, he was right. But John Elliott made it his life's work to provide the lore and mystery of metallurgy with a scientific foundation.

From Damascus steel to Samurai swords to their latter-day equivalents and Stealth-y composites, metal-making has been an almost mystical exercise. Terms like black magic, witchcraft, and alchemy have all been applied at one time or another—and not without cause. Secrets kept and lost characterize this endeavor. Modern-day metallurgists are mindful of the art in their craft, and they wonder where chance ends, and science begins.

"Metallurgy is bringing art and science together," Elliott said that night, "and the science needs to be leavened by practical experience." That statement could serve as his credo. When I talked to him in his office at the Institute a month later, he made the same point.

"When I left MIT [after earning a doctorate in metallurgy under Professor John Chipman], I knew I wanted to teach. But what I needed to learn was embedded in a technological community—and that was industry."

Elliott set out for the real world of iron and steel making. "I wanted to find out what it was all about—to face the day-to-day challenges—not in a casual way, but as a mainstream activity. I did forget some of my chemistry and thermodynamics—there's a flexibility of mind



that comes from teaching—but I acquired other capabilities."

So Elliott spent two years at U.S. Steel, then four years at Inland Steel, both world leaders at the time. His "post-doc" involved mixing research with down-to-earth steel making. "There's so much involved in an industrial process—the human factor, environmental concerns, energy needs, designing the system, the economic equation—that's being an engineer! You can't do research on these issues sitting at your desk."

Real-world experience is a recurring theme in John Elliott's symphony. "You have to go someplace where the problems are real . . . . In steel making, there are requirements imposed by the physical chemistry, but you're dealing with *people*. There's more involved than instructions written on paper. And you can't know what it's like 'out there' until you actually experience it."

Elliott returned to MIT in 1955 as an associate professor of metallurgy, where he began his effort of bringing science and art together. In his research, he tried to understand the physical-chemical behavior of metals. He discovered the patterns of reactions that occur in a blast furnace and revealed the fundamentals of the iron/carbon mix that supports our steel age. He advanced our understanding of the basic thermodynamics of the metal refining system. All the time, he was trying to link the thermodynamic theory with actual processes.

"How can the science be utilized in the industry? That's the goal and the result," he said. "And *improving* the science—that's also our goal." Those improvements and ideas are illustrated in the classic text, *Thermochemistry for Steelmaking*, and in his more than 210 journal articles.

But if the jewels of success are mined from the recognition of one's peers, then John Elliott was truly wealthy. He garnered numerous awards, most recently the 1990 *Tawara Gold Medal* from the Iron and Steel Institute of Japan. "I'm particularly proud of that," he confessed. "It's given only every five years, and only one other American has won it." It was awarded for "contributions to the Iron and Steel industry of the world."

Seeding the field was one of those contributions. His many students have migrated to companies and university laboratories all over the world. Fully 20 percent of the attendees at the Elliott Symposium were former students.

By itself, Elliott's level of productivity was indeed impressive. But he managed to accomplish all he did despite a series of illnesses, beginning with dengue fever contracted at Guadalcanal in World War II. That assault on his immune system led to persistent arthritis. Over the years he underwent critical intestinal surgery and a lower-spine fusion necessitating a full-body brace during recovery. Later he suffered a serious heart attack, bouncing back from that as he had from his previous near-fatal adversities. Between illnesses Elliott continued his world travels, and he kept up with his lab and his writing during recuperations via home computer. His amazing resilience finally ran out with the brain tumor discovered last December.

As he reminisced that summer evening amidst the tapestries, he talked about his family, his garden, his life. "Being a good gardener is easy," he mused. "It's just a matter of staying at it for 30 years." John Elliott mixed iron, steel, and science together for 40 years. From his intellect and perseverance has sprung a legacy of both science and students. □

The author is a biochemist who lives in Concord, Mass.

PHOTO: BARRY HETHERINGTON

over three decades, Weizenbaum has made an outstanding contribution to the field of computer science, publishing widely in both English and German. Moreover, [we] believe that since the appearance of his book *Computer Power and Human Reason* in 1976, Weizenbaum has raised some of the most essential questions in the area of information technology, questions which many computer scientists prefer to remain unspoken. Here is an author whose main contention is that his message be heard precisely by computer scientists, researchers, teachers, and students." . . . **Gerald Jay Sussman**, '68, EECS professor, has been named the recipient of ACM's 1990 Karl V. Karlstrom Outstanding Educator Award for his important contributions to the teaching of computer science. He was cited for his many research papers that are included in both the undergraduate and graduate curricula, particularly those dealing with his work on constraint-propagation models of electrical networks and nondeterministic pattern-matching implementations of logic programming. Sussman was further cited by the awards committee for his "significant pioneering work in introductory computer science education. Among his extensive contributions are two—the Scheme programming language and the text (cowritten with fellow Professor **Harold Abelson, PhD '73**), *Structure and Interpretation of Computer Programs*—that have helped educators reshape introductory courses." A prize of $5,000 is provided by Prentice-Hall Co.

E.L. Burke

Edmund L. Burke, '65, has been appointed director of advanced systems in the Center for Intelligence and Special Programs at the Mitre Corp. in Bedford, Mass. He had been with Mitre earlier, from 1971 to 1982, as a department head concerned with local area networking and secure computer systems. Burke returns to Mitre from Data General Corp., where he worked since 1982, most recently as senior director of Corporate Product Development. . . . **Arthur B. Baggeroer**, ScD '68, has been appointed a Ford Professor of Engineering at MIT. Baggeroer, who holds appointments in the Department of Ocean Engineering and EECS, has made fundamental contributions in signal processing, wave modeling acoustics, and communications. His work has included detection and estimation theory, with application to sonar systems and seismic ocean exploration systems. He is noted for his work in the Arctic where he used large, multichannel arrays to characterize acoustic propagation under the ice and to measure the crustal structure of the Arctic Ocean. He also developed with colleagues at Woods Hole the first high-data-rate digital acoustic telemetry system. With colleagues at Scripps Institution of Oceanography, the University of Michigan, the University of Washington, and the Commonwealth Scientific and Industrial Research Organization's oceanographic center in Tasmania, Australia, he is involved in an experiment to discover whether it is feasible to use acoustics to measure global warming by determining how long it takes sound to travel through the water from the Southern Indian Ocean to receivers throughout the world's oceans. Baggoroer joined the MIT faculty in 1968. From 1983-88 he was director of the MIT/Woods Hole Oceanographic Institution Joint Program. During his tenure a microwave link between MIT and WHOI was established and a new joint SM program was created.

Jeffrey D. Tranen, '69, has been elected a VP of the New England Electric System (NEES), a public utility holding company headquartered in Westborough, Mass. His appointment began April 1, 1990. Previously, Tranen had been a VP of New England Power Co., the wholesale generating and transmission subsidiary of NEES. In his new position, Tranen oversees several departments including alternate energy, power supply, R&D, contact administration, planning and power supply, dispatching, and conservation and load management. Tranen has been with NEES since 1970.

J.D. Tranen

P.G. Jessel

Peter G. Jessel, PhD '72, has been appointed senior VP for Information Technology at EMI Music in New York City. In addition to managing information technology on a worldwide basis for EMI Music, Jessel will provide functional leadership for the company's individual sectors. He joined EMI following five years with McKinsey & Co., Inc. and from 1975–77 he was a faculty member at MIT. . . . **Kerns H. Powers**, ScD '56, was presented with the Engineering Achievement Award for television by the National Association of Broadcasters. Powers was recognized for his 40 years of work on "the development of practical color television systems and new signal processing techniques." He is currently a consultant with the David Sarnoff Research Center in Princeton, N.J. . . . **Timothy Coffey**, '62, has been awarded the **Delmer S. Fahrney** [SM '30] Medal by the Franklin Institute in Philadelphia. Coffey was honored for research in atmospheric physics and related plasmas and for his distinguished management of the Naval Research Laboratory in Washington, D.C. The Fahrney Medal is awarded annually to an individual who has demonstrated outstanding leadership in Science & Technology.

H.M. Schneider

The IEEE has named **Herman M. Schneider**, '62, a Fellow for "contributions to the design of insulation systems for high-voltage ac and dc transmission lines." Schneider, a GE Power Systems Engineering Department employee, is a senior research engineer of high voltage technology at the High Voltage Transmission Research Center in Lenox, N.Y. The facility is owned by Electric Power Research Institute and operated by GE. Since 1985, Schneider has been responsible for advancing technical programs for the development and optimization of high-voltage transmission. He is also in charge of insulation system research programs. . . . Jean-Acardy Meyer and **Stewart W. Wilson**, '60, are editors of *From animals to animats*, proceedings for the first international conference on simulation of adaptive behavior (MIT Press, 1991). According to a book jacket, "These sixty contributions from researchers in ethology, ecology, cybernetics, artificial intelligence, robotics, and related fields delve into the behaviors and underlying mechanisms that allow animals and, potentially, robots to adapt and survive in uncertain environments. They focus in particular on simulation

models in order to help characterize and compare various organizational principles or architectures capable of inducing adaptive behavior in real or artificial animals." Wilson is a scientist at the Rowland Institute for Science in Cambridge. . . . *High Tech Ventures: The Guide for Entrepreneurial Success* (Addison-Wesley, 1991) is a new book by **C. Gordon Bell**, '56 with **John E. McNamara**, '64. According to a book press release, Bell joins with McNamara "to provide would-be entrepreneurs with practical, analytical tools for measuring success—tools gleaned from Gordon's decades of experience in the high-tech industry; tools tested and licensed by Coopers and Lybrand to aid in their own assessment of new ventures. [The book] presents an actual checklist of factors that should be in place at the various stages of a successful start-up, as well as nearly 100 fatal flaws to be avoided."

Cyril J. Brown, SM '51, of Lexington, Mass., died on March 20, 1991. Brown was a retired systems department manager and a quarter-century member at the GTE Corp. in Westborough, Mass. He was a member of the West Point Society of New England, Phi Kappa Phi, and the National Atomic Veterans Association. . . . **Bernard Cohen**, SM '51, of Stamford, Conn., died on March 24, 1991. Cohen was self-employed in medical electronics. He made an unsuccessful bid for Stamford's mayorship as a Republican candidate in the 1981 primary. He was a WW II Navy veteran.

VI-A INTERNSHIP PROGRAM

Director **Kevin J. O'Toole**, NE '57 (XIII), has completed the selection of the incoming VI-A class for 1991. 78 Course VI sophomores have accepted enrollment out of the 197 who applied. Although the numbers are down slightly from last year, Mr. O'Toole feels this is a very good result considering the current business climate.

As this is written, in May, it's the time of year honors and awards are bestowed, of which many VI-As continue to be the recipients (listed alphabetically): **Elwyn R. Berlekamp**, PhD '64, was awarded IEEE's Richard W. Hamming Medal for "profound contributions to the theory and application of error-correcting codes." . . . **Irwin Dorros**, SM '56, was awarded the IEEE's Founders Medal, for "distinguished technical leadership in the evolution of national telecommunications networks and the implementation of a major R&D resource." . . . MIT awarded **Alvin W. Drake**, ScD '62, the Amar Bose Teaching Award, which recognizes outstanding contributions to undergraduate education in the School of Engineering.

On April 3–4 the EECS Visiting Committee met at MIT. Among the 17 members, 6 are VI-A graduates: **Joseph F. Keithley**, SM '38, board chair and founder of Keithley Instruments; **John G. Linvill**, ScD '49, professor and head of Stanford University's Center for Integrated Systems, of which he was a founder; **H. DuBose Montgomery**, SM '72, managing general partner of Menlo Ventures; **Raymond S. Stata**, SM '58, chair, president and founder of Analog Devices, Inc.; **William R. Thurston**, SM '48, retired chair of GenRad; **Andrew J. Viterbi**, SM '57, chief technical officer and founder of QUALCOMM, Inc.

Professional activities of others we've noted: **Anita M. Flynn**, SM '85, presented a paper to the Ultrasonic, Ferroelectrics & Frequency Control Group at the IEEE Boston Section Chapter. . . . **Michael A. Gennert**, ScD '87, professor at Worcester Polytechnic Institute, presented a paper at the IEEE Boston Section Robotics Chapter. . . . **Dennis L. Polla**, EE '81, professor at the University of Minnesota, was mentioned in articles in *Science News* and *Newsweek* for his work in micromachines.

VI-A's with whom we've had contact since our last writing: **John D. Chisholm**, SM '76, continues his activities with the MIT Club of Northern California where he is serving as president. They have a very active "Science Literacy Group" to link scientists and engineers with pre-college students on a tutorial basis. . . . **Stephen M. Foster**, SM '90, stopped by the office one afternoon for a chat. He's with Andersen Consulting here in Boston. . . . **A. I. Xavier Douwes**, SM '90, also with Andersen Consulting, came by to chat with Mr. O'Toole and me. . . . **Craig E. Goldman**, SM '81, called to get some general salary information in connection with hiring for Clearpoint Research Corp. in Hopkinton, Mass., the company for which he works. During our conversation Craig extolled the virtues of the MIT/VI-A combination, saying "even after 11 years out, these both make a difference." . . . **Jay Goldman**, SM '73, I chanced to meet in a parking lot in Wellesley. Jay is with PRIME Computer and lives in Wellesley. . . . **John W. Jarve**, SM '79, was East on business and stopped in for a chat. This gave us a chance to discuss West Coast thoughts about next year's VI-A 75th Anniversary celebration. . . . **John G. Linvill**, ScD '49, mentioned earlier, recently retired from Stanford University. John served as an assistant in our VI-A Office from the fall of 1947 through the summer of 1951. . . . **Peter M. Osterberg**, SM '80, was in our offices getting information. Peter is with Digital Equipment Corp.

Preliminary thoughts are being gathered about a celebration of the 75th Anniversary of the VI-A Program next year. That's not far off, for planning purposes, and I've already talked with a few people and would appreciate additional feedback. It's looking as if the best time to schedule the activities would be during the Alumni/ae Week activities in June, when many would already be on campus and others more apt to come.—John A. Tucker, Director (Emeritus) VI-A Program, MIT, Rm 38-473, Cambridge, MA 02139-4307.

VII BIOLOGY

Maria Jasin, PhD '84, is an assistant professor at Sloan-Kettering Institute and Cornell Medical College. . . . **Robin D. Kelley**, SM '88, is a technology specialist and patent agent for Testa, Hurwitz & Thibeault in Boston. . . . **Leonard Guarente**, '74, Course VII associate professor, has received a two-year $180,000 research grant from the American Cancer Society to support his studies of cells. The grant was part of $3.4 million awarded by the Society for the research of 25 Massachusetts scientists, effective January 1. Guarente is studying the transcription activity of eukaryotic cells. Transcription is a process that controls cell growth.

S.E. Straus

Stephen E. Straus, '68, has been appointed chief of the Laboratory of Clinical Investigation at the National Institute of Allergy and Infectious Diseases, at the National Institutes of Health. Straus's research is focused on the molecular biology, pathophysiology, natural history, treatment, and prevention of human herpes virus infections. According to an NIAID press release, "Using increasingly refined molecular tools, Straus and his coworkers were among the first to dissect the DNA of the varicella zoster virus. In so doing, they identified many of its major properties." . . . *Neurocomputing 2: Directions for Research* (MIT Press, 1990), is a new book edited by **James A. Anderson**, '62, Andras Pellionisz, and Edward Rosenfeld. According to the book jacket, the publication is a collection of "41 articles covering net-

1912–1991

Cecil E. Hall

Cecil E. Hall, PhD '48, a retired professor of biophysics who played a major role in the development and use of the electron microscope, died March 5 in Jasper, Ark., at the age of 78. He formerly was a resident of Lincoln, Mass.

A native of Nottingham, England, Hall received a BS from the University of Alberta in Canada in 1935 and an MA from the University of Toronto in 1936. He came to MIT in 1941 as a research associate and member of the faculty in the Department of Biology, becoming an associate professor of biophysics in 1947 and a full professor in 1964. He retired in 1970.

While at Toronto, Hall built an electron microscope "from scratch" for the Eastman-Kodak Co., according to Francis O. Schmitt, Institute Professor Emeritus and professor emeritus of biology. Over the years, Hall and Schmitt collaborated on a number of research projects involving electron microscopy. Hall's extensive publications included a widely used textbook, *Introduction to Electron Microscopy*, in the 1950s.

During WW II, Hall, Schmitt and Irwin W. Sizer, H, professor emeritus of biochemistry, investigated materials of value in the treatment of burns and also the nature of the material embedded in the skin of victims of blast pigmentation.

In 1960, Hall was part of a team that made the first direct pictures of tiny antibody molecules, the body's agents of immunity against disease. The electron microscope permitted direct visualization of individual molecules, providing more exact information on the size and shape than could be obtained by any other method. □

work architecture, neurobiological computation, statistics and pattern classification, and problems and applications, that suggest important directions for the evolution of neurocomputing."

The Alumni/ae Association has been notified that **Trent Sumner Russell**, MPH '42, of Castleton, N.Y., died on March 20, 1991. There was no further information provided.

VIII PHYSICS

Yun-Tung Lau, PhD '88, writes: "I was recently awarded a National Research Council-NASA Research Associateship. I will work on problems related to space plasma physics at the NASA Goddard Space Flight Center in Maryland. . . . **Steven E. Koonin**, PhD '75, is a professor of theoretical physics and chair of the faculty at Caltech. . . . **Mehran Kardar**, PhD '83, Course VIII associate professor, has been selected as the first recipient of the Class of 1948 Professorship. He will hold the chair for a two-year term. The chair was established by the class in celebration of their 40th reunion. Kardar, a condensed matter theorist who works primarily on problems in statistical physics, has made important contributions in a wide variety of areas, including dynamics of growing interfaces, polymers in redom media, morphological transitions in membranes, and the phases and phase transitions in thin films and layers. He was a junior fellow at the Harvard Society of Fellows from 1983-86 and was appointed to the MIT faculty as assistant professor of physics in 1986. *(See also "Under the Domes" in this issue.)*

Hans Mark, PhD '54, chancellor of the University of Texas System, was the honorary chair of the International Space Development Conference held last May in San Antonio. The goal of the conference was for attendees "to take action and acquire tools to create a spacefaring civilization and establish communities and industry beyond the Earth." . . . **Ralph M. Moon, Jr.**, PhD '63, has been accorded the rank of corporate fellow at Martin Marietta Energy Systems, Inc., in Oak Ridge, Tenn. According to a company press release, "Moon, who heads the neutron scattering section within ORNL's Solid State Division, is internationally known for his work using neutron scattering as a tool for revealing the fundamental properties of magnetic materials. Since joining the lab in 1963, he has contributed to the development of neutron polarization analysis, a technique now used at neutron scattering centers throughout the world. Moon has also been a principal advocate and planner of the Advanced Neutron Source, a new state-of-the-art research reactor facility proposed for construction at ORNL, which will serve the national scientific community."

The Optical Society of America (OSA) has selected several Course VIII alumni as award recipients. **James P. Gordon**, '49, of AT&T Bell Laboratories is the 1991 recipient of the Max Born Award for achievement in physical optics. Gordon is recognized for "his manifold original contributions to physical optics, including masers, the theory of quantum noise in lasers and in optical communications, radiation pressure, ultrafast phenomena, and solitons in optical fibers, and for his fruitful and selfless assistance to so many others. With Zeiger and Townes, Gordon developed the theory for, and built, the first maser. He was among the first to recognize the nature and importance of quantum noise. Gordon's understanding of soliton processes and his theories of the interaction among solitons in optical fiber broke important new ground in the theoretical understanding of soliton propagation effects in fibers." . . . **Daniel Kleppner**, Lester Wolfe Professor of Physics at MIT and associate director of the Research Lab of Electronics, is the 1991 recipient of OSA's William F. Meggers Award in spectroscopy. Kleppner is recognized for "his outstanding contributions to spectroscopy, including development of the hydrogen maser, spectroscopy of Rydberg states, and analysis of the interaction of atoms with electromagnetic fields. He played a significant role in the development of the hydrogen maser, for which Norman F. Ramsey won the 1989 Nobel Prize. Among his contributions to spectroscopy, Kleppner studied and clarified the chaotic behavior of Rydberg states in applied magnetic and electric fields. He also has demonstrated the enhancement and suppression of spontaneous emission in optical cavities."

This year's R.W. Wood Prize, an OSA award recognizing an outstanding discovery, scientific or technological achievement, or invention in the field of optics is shared by **Thomas F. Deutsch**, Havard-MIT Health Sciences lecturer and Massachusetts General Hospital research physicist, **Daniel J. Ehrlich**, Lincoln Lab senior staff member, and **Richard M. Osgood**, PhD '73, MIT Spectoscopy Lab research affiliate and Columbia University professor. The three are cited for "their invention of laser photochemical deposition and the application of laser–induced photochemical reactions to materials processing. Deutsch, Ehrlich, and Osgood have applied lasers to the development of a fundamentally new processing technology for semiconductor electronics. Their research, which began with their collaboration at MIT Lincoln Lab, has spanned the range from basic discoveries to demonstrations of solutions to practical, technical problems involving the laser–controlled etching of microelectronic devices. Their work has led to a fundamentally new approach to electronics processing, an area in which many industrial organizations have now initiated development programs."

Alan C. Bemis, SM '30, of Concord, Mass., died on January 7, 1991. He served in World War II and worked for many years as director of MIT's Weather Radar Research Project. He was a director of the Bemis Brother's Bag Co. in Minneapolis during the 1960s and 1970s. More recently, he served as a director of the Metritape Co. of Littleton. Bemis was a professor of physics at MIT and maintained a long interest in education. Much of his life was occupied with sailing and small boat cruising on the Maine Coast. He owned a home in the coastal town of Brooklin, Maine. He also had a lifelong interest in airplanes and automobiles, and he owned and restored a 1913 Rolls Royce touring car. . . . The Alumni/ae Association has been notified that **Clinton J.T. Young**, SM '36, of Alexandria, Va., died on March 30, 1991. No further information was provided.

X CHEMICAL ENGINEERING

Peter C. Farrell, SM '67, reports: "I am chair and CEO of ResCare, Ltd. in Sydney, Australia and also visiting professor in biomedical engineering at the University of New South Wales. ResCare manufactures and markets nasal continuous positive airway pressure devices and respiratory masks worldwide. The main use of nasal CPAP is for obstructive sleep apnea treatment but it has many other applications. From 1978–89 I was Foundation Professor of Biomedical Engineering at UNSW; from 1984–89 I was also VP for R&D with Baxter Healthcare of Deerfield, Ill. I set up ResCare as part of an MBO (in 1989) from Baxter of their respiratory technology. . . . **Dave Wickham**, SM '84, writes: "Since 1986 I have been running my own business in South Africa, where we import and distribute engineering software for the process industry. Occasionally I act as an external lecturer or examiner for Natal University. Last year I got married to Glen, and we are

expecting our first child in May! Best regards to all my friends from MIT!!"

David B. Sudikoff, SM '78, reports: "Living the California Life. I'm married, two kids, living in wonderful Berkeley, Calif. Just quit my job, planning to become the next Steve Jobs." . . . **William Taggart**, SM '59, has become a VP of the Trust Division at Putnam Trust Co. in Greenwich, Conn. Formerly he was a partner with the Liberty Capital Group, Inc., also in Greenwich. . . . **Randall P. Field**, SM '83, is now technical account manager at Aspen Technology, Inc. He had been manager of Bioprocess Simulation for the Cambridge-based firm.

T.R. Keane

Thomas R. Keane, '50, has been named a Du Pont fellow, the highest level of professional recognition in the company. He is the 19th Du Pont Fellow and the second Du Pont Engineering employee to achieve the honor. Keane has been with Du Pont for 37 years. He has led development and application of next-generation process technology and reactor design to improve the competitiveness of several company businesses, including CFC alternatives and THF, a raw material used in the "Lycra" business.

Michael T. Klein, ScD '81, professor of chemical engineering at the University of Delaware, has been named chair of the University's Department of Chemical Engineering. According to a Delaware press release, Klein is "established as a major research contributor in the field of chemical reaction engineering and chemical modeling of complex reaction systems and consults regularly with major oil and chemical companies. His cumulative funded research proposals total approximately $5 million." . . . **Charles A. "Andy" Stokes**, ScD '51, was recently honored by the Department of Engineering at the University of Florida with the R.W. Fahien Alumni Award, which salutes his distinguished service and contributions to the chemical engineering profession. Stokes has set up a professorship in chemical engineering at the University of Florida and a scholarship fund in the Technology and Policy Center at MIT. . . . **Paul N. Blumberg**, '65, president of Ricardo-ITI, Inc., in Westmont, Ill., has been elected a Fellow of the Society of Automotive Engineers. He was cited for "the development and application of cost-effective, computer-based design and analysis methods for internal combustion engines and powertrain systems."

XI URBAN STUDIES AND PLANNING

Philip Shapira, MCP '79, reports: "In January 1991, I joined the faculty of the School of Public Policy at Georgia Institute of Technology. I'm now conducting research and teaching in the areas of industrial policy, economic and regional development, and technology policy. Last year, I wrote *Manufacturing Modernization: New Policies to Build Industrial Extension Services*, published by the Economic Policy Institute. Last fall I was married to Krassimira Paskaleva in Veliko Turnovo, Bulgaria. Krassi is now working as a research fellow at the Georgia Tech Research Institute. We are both working on a project looking at environmental policy and economic reform in Bulgaria's Borgas Region." . . . **Eric R. Hansen**, PhD '84, reports: "As senior regional economist for SRI International, I have recently completed a technology-driven economic development strategy for the restoration of the opto-electronics industries in eastern Germany as well as a strategic futures study for the state of Arizona. I also recently published 'Agglomeration Economics and Industrial Decentralization' in the *Journal of Urban Economics*." . . . **Philipe Annez**, PhD '81, is currently chief of the regional mission of the World Bank in Bangkok, Thailand, covering the activities of the World Bank in Burma, Thailand, Lao PDR, and Vietnam. . . . **Martha E. Oesch**, MCP '90, is director of employment and training for Community Action, Inc., in Haverhill, Mass.

Wasting Away: An Exploration of Waste: What it is, How it Happens, Why We Fear it, How to Do it Well (Sierra Club Books, 1991), is a new book by Kevin Lynch, '47, (IV), edited by **Michael Southworth**, PhD '70. According to a book release, "Lynch, who died in 1984 as this book was nearing completion, was a noted urban designer and professor of city planning at MIT for more than 30 years. A student of Frank Lloyd Wright at Taliesin, his design projects included work on Boston's waterfront and the University Circle area of Cleveland. The recipient of many professional honors, he was also the author of eight books, including his classic *The Image of The City*. Southworth, a student and colleague of Lynch, finished preparing the manuscript of *Wasting Away* for publication and contributed the photographic essay 'Looking At Waste.' He is an associate professor of urban design and environmental planning at the University of California at Berkeley." . . . **Dowell Myers**, PhD '81, has edited *Housing Demography: Linking Demographic Structure and Housing Markets* (University of Wisconsin Press, 1990). According to the book jacket, "this volume is the first effort to give cross-disciplinary investigations of population and housing a definition and a common name: housing demography. Essays commissioned especially for this volume address four main issues: household formation and composition; housing choices; housing construction and inventory change; and spatial patterns and consequences." Myers is associate professor of planning and development at the University of Southern California. He is also a faculty research associate of the Population Research Laboratory and codirector for market studies of the Lusk Center for Real Estate Development at USC.

XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

David D. Jackson, PhD '69, sends word from Los Angeles: "I am now professor of geophysics at UCLA and was elected secretary of the Seismology Section of the American Geophysical Union. I am chair of the Geodesy Working Group at the Southern California Earthquake Center. Our family (wife Kathy, daughter Kelly, and son Morgan) was featured in a documentary on public television, 'The Michiyo and Kelly Story: A Quest for Education,' comparing American and Japanese education." . . . **James L. Powell**, PhD '62, is CEO and president of the Franklin Institute in Boston. He had been president of Reed College in Portland, Ore.

Amos Nur, ScD '69, professor and chair of Stanford's Geophysics Department, and Chris MacAskil have won the Silver Apple Award in Physical Sciences for their film, "The Walls Came Tumbling Down: Earthquakes in the Holy Land." According to a Stanford release, "A native of Israel, Nur began studying ancient earthquakes in the Jordan rift zone in the hope that the lengthy recorded history of that region would divulge a method for predicting future earthquakes. Earthquake prediction is still elusive, but Nur's studies have documented quakes from Biblical times to the present. The film title comes from Nur's assertion that Jericho's 'walls came tumbling down' because an earthquake occurred while Joshua and his army were camped outside the ancient city around 1000 B.C." Nur joined

Stanford in 1970, has chaired the department since 1986, and has held the Wayne Loel Professorship of Earth Sciences since 1988.

XIII OCEAN ENGINEERING

Thomas Diamant, SM '69, sends word from Potomac, Md.: "I was elected president and CEO of John J. McMullen Associates, Inc., last February." . . . **Lloyd S. Beckett III**, SM '82, is a pipe shop foreman at Bath Iron Works in Bath, Maine. . . . **Richard B. Hood**, SM '81, is now CEO as well as president of Hood Enterprises, Inc., in Portsmouth, R.I.

Charles R. Cushing, '60, has been elected a Fellow of ASME. He is president of C.R. Cushing & Co., in New York City. Cushing "has contributed generously to the mechanical engineering aspects of designing and building ships. He was closely involved in the development of the containership concept of transporting cargoes, portable power for refrigerated cargoes, shipboard gantry cranes, and other large cargo handling devices essential to serving underdeveloped ports, and the design of a pipe-laying ship, capable of laying 24-inch-diameter pipe at speeds up to three knots." . . . Commander **Raymond S. McCord**, OCE '81 (USN), former repair officer of the USS *Samuel Gompers* and currently intermediate maintenance coordinator and diving and salvage officer for the commander-in-chief of the Atlantic Fleet, was selected for the Claud A. Jones Award for "improving operational engineering and material readiness of maritime defense forces."

The Alumni/ae Association has been notified that **Francis B. Bushey**, '42, of Delray Beach, Fla., died on January 8, 1991. There was no additional information provided.

XV MANAGEMENT

Richard Krueger, SM '90, writes: "I am currently a program manager at Digital, working on DEC's sourcing strategy, marketing analysis, technology transfers, and technology management." . . . **Robert C. Salipante**, SM '81, sends word from Rocky River, Ohio: "I am executive VP for banking services at Ameritrust Corp., with responsibility for all systems, operations, and consumer lending products. I have three children, Katie, 9, Paul, 6, and Michael, 1." . . . **Demie Stathoplos**, SM '83, reports: "After six years at MCI Telecommunications, I decided to make the switch to the non-profit sector. I have been executive director of D.C. Habitat for Humanity, a non-profit housing developer, since January 1990. I love the commitment of the people in the non-profit world. The change has left me energized and happy. I'm also teaching workshops on 'Eliminating Racism' at the Washington Ethical Society." . . . **Brilsford B. Flint**, '83, writes: "I have left Bain & Co. to become senior director of strategic planning at EMI Music in New York. Artists on EMI labels include Bonnie Raitt, Wilson Phillips, Doobie Brothers, and M.C. Hammer. Along with numerous acquisitions, I'll be working on manufacturing and distribution planning and market segment strategies." . . . From London, **Kevin Rowe**, SM '85, writes: "I recently became one of the founding partners of Buchanan Partners, an investment company specializing in the application of quantitative financial analysis to international securities markets." . . . **David L. Bodde**, SM '73, sends word from Kansas City, Mo.: "On January 7, I took a position as VP of the Midwest Research Institute and president of its for-profit subsidiary, MRI-Ventures. The MRI is a not-for-profit energy and environmental laboratory. It operates the Solar Energy Research Institute for the Department of Energy and has offices in Research Triangle Park and Washington. MRI-Ventures is a technology licensing company."

Alan S. Orloff, SM '87, is living in Fairfax, Va., working for Systems Engineering and Management Associates, Inc., and was planning a June wedding. . . . **Takashi Miyake**, SM '87, reports: "I left the Long-Term Credit Bank of Japan in 1989 to join First Boston (Private Placement Group) in New York. In December 1990, our first child was born, a baby girl named Yumi Kristin Miyake." . . . **Hiroo Nozawa**, SM '71, writes: "I was transferred from our Tokyo office to our New York office. I am executive VP and general manager of the North American Administration Division with the Mitsubishi Bank, Ltd." . . . **M. Cory Zwerling**, SM '85, reports: "Greetings from Princeton, N.J.! For the last three years I've been working for Bristol-Myer Squibb. Currently, I am the worldwide product manager for an antihypertensive product (captopril). The job is very interesting and rather dynamic. Unfortunately, living in New Jersey is not overly exhilarating! I hope everything is going well for all of you! . . . **Yoichi Yokomizo**, SM '86, sends word from Tokyo: "I was recently promoted to manager of the planning and investment team of the Information Systems & Services Group in the Planning and Coordination Department at Mitsubishi Corp." . . . **John A. Dallen**, SM '75, writes: "I am now a VP with Nolte & Associates, a civil engineering firm headquartered in San Jose, Calif. I'll be moving my family from St. Louis, Mo., and locating in Sacramento, Calif."

From Baltimore, Md., **Richard S. Livingston**, SM '84, reports: "I formed my own business, The Richstone Corp., in November 1990. Richstone is a private real estate investment, development, and construction/contracting company. . . . **John E. Osborne**, SM '65, writes: "I'm currently director of finance for Apple Computer, Inc., in Cupertino, Calif. I just completed the Stanford Executive Program last summer (a two-month MBA update). It's nice to know that they used the same movie (*Twelve Angry Men*) that MIT used in 1965 for part of the teaching of the course. We even read an article written by a 1965 Sloan classmate of mine—**Henry Mintzberg**, SM '65, PhD '68—small world!" . . . From **Jeffrey E. Seifert**, SM '86, in Brewster, N.Y.: "I have been with Bankers Trust since graduation. Since 1990, I have been doing investment managment in Tokyo. I work alongside **Hideki Takayama**, SM '87. . . . **David Levinthal**, SM '81, sends word from New York City: "I received a 1990–91 NEA artist's grant in photography. In 1989 I became the first photographer to be commissioned to do an artist's ad for Absolut vodka. Currently I am exhibiting my work in New York, Brussels, and Zurich." . . . From Overland Park, Kans., **Stephen Pearse**, SM '82, reports: "I was promoted from director of Network Systems Planning and Development to AVP for Custom and Data Network Services at U.S. Sprint." . . . **Gene Emmer**, SM '89, writes: "In June 1990 I became product manager of Roche Biotech Products for Swizerland. An American product manger is pretty unusual here, but so far people have been quite accepting. Both sales and my German have been improving as a result." . . . **David B. Sayles**, SM '83, writes: "I left Wall Street (voluntarily) to join the International Finance Corp., part of the World Bank Group. I will be helping private-sector companies in developing countries (primarily Southeast Asia) issue debt and equity securities in the international capital markets. The job should be fun, and Washington is great." . . . **Akira Kakihara**, SM '89, sends word from New York City: "I work as a manager in the Real Estate Lending Group for Kyowa-Saitama Bank. The bank is the result of the merger of two Japanese banks—Saitama Bank and Kyowa Bank. This merger was based on long-term strategies of both banks and was announced in November 1990. We have worked day and night for the

1936–1991

David O. Wood

David O. Wood, 54, director of MIT's Center for Energy Policy Research, died unexpectedly of a heart attack April 28 at his home in Belmont.

Wood, a senior lecturer at the Sloan School of Management, was widely known for his pioneering work on the application of computer models to the economic analysis of energy problems. He held a series of government posts from 1964–1976 that brought economics to bear on energy policy analysis. His colleagues respected him for his ability to combine a scholarly approach with a keen understanding of how the policy-making apparatus of government functions.

Wood began his work on energy problems in 1964, when he joined the federal Office of Emergency Preparedness as a staff economist. He became chief of the Applied Economics Division in 1968 and deputy director of the office in 1970. Three years later, when the first energy crisis hit the nation, a new Federal Energy Administration was created to handle research on energy issues, and Wood became director of its Office of Energy Systems.

He left that post in 1976 to become associate director of the MIT Energy Laboratory, with a specific assignment to build the laboratory's work in energy economics and policy. In 1986 he was appointed director of the MIT Center for Energy Policy Research, a joint enterprise of the Energy Laboratory, the Department of Economics, and the Sloan School of Management, which focuses specifically on energy policy.

While leading the center's programs, Wood also made fundamental research contributions to the understanding of the economics of energy demand and the relationship of energy policies to national productivity and economic growth. he was actively involved in the teaching programs of both the Sloan School and the Department of Economics.

In the last few years, Wood had lectured and written extensively on issues linking energy and the environment, particularly the problem of global warming. Among his latest publications is a book, edited with colleagues, on *Energy and the Environment in the 21st Century*, published by the MIT Press. □

merger, but now we realize how difficult it is to coordinate two different companies—both are equally sized Japanese banks without strong cultures, however, equal merger prevents us from taking initiative in either of them. We will see how these problems are going to be solved and by that time I think I can write many case studies out of my experience!"

"After being in Cambridge for five years," writes **Scott Wieder**, SM '86, "my family and I have moved out to the 'burbs.' We are now living in the woods of Acton, Mass. After being in the house a few months, we decided there were too many empty rooms, so we filled one of the rooms with a new baby boy. Seth Joshua was born on February 28, 1991." . . . **Buckner Brown**, SM '82, reports: "After a two-and-one-half-year assignment in Tokyo, I have returned to New York where I am a member of Lehman Brothers' Mergers & Acquisitions Dept." . . . **Suellen Fausel**, SM '86, writes: "My husband Chuck is finishing his second year of study for the Lutheran ministry at Concordia Theological Seminary in Fort Wayne, Ind. (Two down—two to go!) Our *big* news, however, is that after 21 years of marriage, we are happily expecting the birth of our first child in mid-August! I am still working in engineering management for Delco Electronics Corp., (a subsidiary of GM), and am a member of the GM University Recruiting Team for MIT." . . . **David E. Thomas**, SM '80, reports: "My wife Diane and I have recently relocated to the Melbourne, Fla.-area from Nashua, N.H., where I was the program manager for the Sanders-GE joint venture, developing the Electronic Combat Suite for the Air Force's Advanced Tactical Fighter. I have accepted a position with Grumman Aerospace doing advanced development work for the Air Force (Army Joint STARS Aircraft Program)." . . . **Brandon Minor**, SM '77, is a VP at Chase Manhattan Bank in New York City

Hank Perritt, SM '70, writes: "I am still a law professor at Villanova, chair the law & computers section of the Association of American Law Schools, and have written six books on employment law, information technology law, and legal automation." . . . **Paul W. Jahn**, SM '83, sends word: "I have just moved to Air Products and Chemicals' new office in Norderstedt, Germany, as business manager for polyurethane additives in Europe. I will be based in Germany for two years. I will also be managing the integration of PURA International, a small chemicals company also in Norderstedt., recently acquired by Air Products, into our existing portfolio of polyurethane-related business." . . . **Akifumi Shiozaki**, SM '84, reports: "I am still working for the London branch of Sumicomo Trust & Banking Co., Ltd. I am now manager of the Aviation Finance Department and have been involved in aircraft finance for three years. We underwrote and successfully syndicated the 'Asset Value Guarantee' for United Airlines in 1989, which won 'The Deal of the Year America' Prize from *Air Finance Journal*." . . . From Tokyo, **Martin Bantle**, SM '89, writes: "On December 5, 1990 my company, Echelon Corp. announced Lonworks Technology, our flagship product, to the public. We have had tremendous response from interested companies throughout the world. In March 1991 we announced the formation of Echelon Japan K.K. The subsidiary is primarily focused on Japan; however, it will be responsible for the entire Asia Pacific Region. I am heading up the subsidiary and currently living in Minato-Ku, Tokyo. If anyone makes it out to Japan, feel free to call me."

Guy Barudin, SM '87, reports from Flushing, N.Y.: "We are expecting our second baby and I'm working at Dillon Read on emerging company finance. Congratulations to **Steve Wolf**, SM '88, and **Michelle Wolf**, SM '88, on the arrival of their third child, Bryant, last March." . . . **Larry Kooper**, SM '88, writes that he is a marketing manager for new products at Reuters. . . . **Dave Lemos**, SM '88, reports: "I am working as an international treasury consultant for Sweden's third largest company, Electrolux AB, based in Zurich, and have lived/worked in Switzerland, Germany, Sweden, England, Ireland, and the U.S. in the last two years. Next possible assignment/residence might be Toronto, Ontario." . . . **Charith Perera**, SM '83, sends word from Atlantic Beach, Fla.: "I married Chinta and we have two kids, Samantha, 2; and Chris, 7 months. I am director of marketing with CSX Transportation." . . . **Kathy L. Kessel**, SM '88, writes: "I was recently promoted to senior program manager of business partners at ICAD in Cambridge I am responsibile for strategic partnerships with ICAD's business partners, including IBM, McDonnell Douglas, and Computervision. On a personal note, I am currently building a new house in Sudbury, Mass." . . .**Ellen Quackenbush**, SM '85, writes: "After a four-year wait, Rick and I have been 'assigned' (first step in adoption) a Korean baby girl. Predictably. our five-year-old son (also a Korean adoptee) is much more interested in the puppy we promised *he* could 'adopt.' I'm rolling along at DEC, pleased that my market research group continues to survive all the layoffs."

Genelle Trader, SM '80, is living in Newport Beach, Calif., and working for AST Research as director of Portable Systems Marketing. . . . From Rockville, Md., **Suleiman Hessami**, SM '85, reports: "I was promoted to director at MCI Communication. I spend most of my working hours reviewing proposals and financial analyses. I enjoy my work and love the company and people I work with. Outside of work, I am busy with my kids, ages 5 and 2. They are both great and future Sloan students. If you are in the D.C. area, give me a call. Let's have lunch or something."

F.A. Bielawa

Frederick A. Bielawa, '59, has been appointed director of financial planning in Eastman Kodak's division of corporate commercial affairs. Bielawa served previously as director of financial planning in the company's Asia, Africa, and Australasian Region. . . . **Richard Fischer**, SM '84, writes: "I am the Collider Dipole Magnet business manager. This is the largest single subcontract for the Superconducting Super Collider Lab. (SSCL). The construction of the SSCL is stretching the limits of existing superconducting technology. The instru-

ment, when it is finished, will be used to discover new secrets about the nature and form of matter.". . . **Ross Ely**, SM '89, and **Suzanne Finnigan**, SM '88, were married on September 29, 1990, in Cupertino, Calif. Ely works at Apple Computer, Inc., as a product manager of graphics products. Finnigan is co-founder and head of business analysis at WorlDvoice, Inc., a start-up offering worldwide network services for voice messaging.

Toni Y. Shimura, SM '81, **Bernard Scozzafava**, SM '89, **David R. Mannheim**, SM '88, and **Mark Regan**, SM '83, have been named assistant VPs at Massachusetts Financial Services Co. Prior to these promotions, Shimura was an analyst, Scozzafava a high-yield bond analyst, and Mannheim was an investment analyst for the Boston-based firm. Regan was a security analyst for the Eaton Vance Corp., also in Boston. . . . **Edward S. Hyman, Jr.**, SM '69, has resigned as vice chair at C.J. Lawrence, Inc., in New York City. He is planning to start up a consulting firm **Melford E. Monsees**, '58, has retired after 20 years as resident coordinator of the University of Missouri-Columbia Graduate Engineering Program in Kansas City. The program, developed by Monsees, provides a Master of Science degree in civil, electrical, industrial, and mechanical engineering.

Subhash K. Batra, SM '77, professor at North Carolina State University's College of Textiles, is the 1990 recipient of the American Society of Testing Material's Harold De Witt Smith Award. This award is presented for outstanding achievement in the science of textile fiber utilization. . . . **George P. Richardson**, PhD '85, has published his second book, *Feedback Thought in Social Science and Systems Theory* (University of Pennsylvania Press, 1991). According to the book jacket, the book "is an original investigation in the history of an idea and a way of thinking in the social sciences—the loop concept underlying the notions of feedback and circular causality." Richardson is an associate professor of public administration and public policy at the Nelson A. Rockefeller College of Public Affairs and Policy at the State University of New York at Albany.

Sloan Fellows

Robert H. Rollins, SM '70, writes: "I retired from NASA with 30 years service. I am incorporating director and corporate secretary of the Hagerstown Roundhouse Museum, which is purchasing 43 acres including central shops and roundhouse from the Western Maryland Railway in Hagerstown, Md. The museum will collect, rebuild, and operate historic steam and diesel locomotives, railway cars, and other equipment as a 'working' museum." . . . **John T. Howley**, SM '73, reports: "I am VP for International Affairs at the National Association of Realtors in Washington, D.C. I am involved in some events in Eastern Europe and elsewhere. I am also a bed & breakfast innkeeper on lovely Solomons Island, a little over an hour from D.C. on the western shore of the Chesapeake Bay." . . . From Hampton, Va., **Sammie D. Joplin**, SM '86, writes: "I was recently selected as chief of the Facilities Engineering Division at NASA's Langley Research Center."

Stephen N. Gerson, SM '89, is medical director for the Division of Behavioral Health Care at Peer Review Analysis, Inc., in Malden, Mass. Prior to this, Gerson worked as a consultant. . . . **James C. Foster**, SM '85, is president and COO for Charles River Laboratories in Wilmington, Mass. Previously, he was the company's executive VP. . . . The following alumni have new affiliations: **Roger W. Hale**, SM '79, is a director for H&R Block in Kansas City, Mo. He continues as chair of the Louisville Gas & Electric Co. in Louisville, Ky. . . . **Glen D. Foss**, SM '87, is a director of Madison Paper Industries. He continues as manager of human resources for the Maine firm. . . . **Joseph P. Lacher**, SM '84, is a director of SunBank/Miami, N.A. He continues as VP of Southern Bell Telephone Co. in Miami.

Senior Executives

Jack W. Johnson, '82, is VP for human resources at LTV Aerospace & Research Corp. Formerly, he was director of labor relations and personnel for the Dallas-based company.

J.W. Hart, Jr.

James W. Hart, Jr., '82, VP for public affairs at Panhandle Eastern Corp., has been honored by the Texas Public Relations Association with the Outstanding Public Relations Practitioner Award. He is the fourth person in the 37-year history of the association to receive this award. Hart, who joined the company in 1988, is a brigadier general in the U.S. Air Force Reserve and the reserve assistant to the director of public affairs in the Office of the Secretary of the Air Force and the Pentagon. . . . . **James O. Zane**, '82, is senior VP of EG&G, Inc.'s Department of Energy in Idaho Falls, Idaho. He had been president and general manager of EG&G Idaho, Inc., also in Idaho Falls.

Burton S. Goldberg, '81, of Somers, N.Y., died on November 25, 1990. The retired IBM Corp. executive died of a heart attack while swimming at the White Plains YMCA. Golberg had been with IBM for 25 years, working in offices across the country and in Paris. He was an advisor to New Enterprise Associates and to the Mayfield Fund and was on the board of several computer software companies. . . . The Alumni/ae Association has been notified that **Gainor J. Lindsey**, '79, of Arlington, Tex., died of cancer on November 1, 1990. Lindsey was a senior VP for Bell Helicopter. No further information was provided.

Management of Technology Program

Virginia M. Moszkowicz, SM '87, has been promoted to manager of quality assurance/industrial engineering in the Kodak Apparatus Division at Eastman Kodak Co. in Rochester, N.Y. . . . **Tom Lydon**, SM '90, has finally gotten some mileage from his MOT thesis work. He presented a paper, "Software Technology Insertion: A Study of Success Factors" (based on his thesis), at a NASA software engineering workshop at the Goddard Space Flight Center last year. He presented it again recently at the NSIA conference in Washington, D.C. . . . **Mike Hatcher**, SM '89, stopped into the program office to visit while in the area on business. He and his wife are busy with plans to build a new home. . . . **Kip Steveley**, SM '90, stopped by to visit with Jennifer Mapes in the office last month. He was here to visit General Motors-sponsored Leaders for Manufacturing students.—Fay Wallstrom, Management of Technology Program, MIT Rm. E56-304, Cambridge, MA 02139.

XVI AERONAUTICS AND ASTRONAUTICS

Peter Mirchandani, ScD '75, writes: "I joined the Systems & Industrial Engineering Department at the University of Arizona at Tucson as professor and department head. The department consists of 19 faculty, 160 undergraduates, and 70 graduate students, and offers two bachelors degrees, three master's, and a doctoral degree. Previous to that, I was professor of electrical, computer, and systems engineering at Rensselaer Polytechnic Institute. I am an active researcher in optimization and probabilistic systems analysis, and work on applications in manufacturing, transportation, and telecommunications."

J.D. Beecher

Rear Admiral **John D. Beecher**, SM '60, USN (ret.), has been awarded the Frank G. Law Award for 1990 by the American Society of Naval Engineers (ASNE), for "his support of the Society's interests, goals, and ideals over a number of years." Since his retirement from the Navy in 1984, Beecher has served in industry and as VP of ASNE. . . .

Edward B. Bokhour, SM '88, reports: "I am working at Payload Systems, Inc., in Cambridge as hardware development manager on the MIT SERC/NASA Langley Middeck O-Gravity Dynamics Experiment, a space shuttle middeck locker structures/fluid dynamics experiment, scheduled to fly aboard STS-48 early this fall." . . .

Arthur J. Wennerstrom, SM '58, sends word: "I recently spent six months studying French with my wife in Washington, D.C. I began a new job on July 1 in Paris as director of AGARD (a NATO agency)." . . . **Rainer M. Brusch**, SM '82, writes: "I was formerly top executive at various companies, and now I reside in Berlin and work as a business consultant (financial, electronic data processing, organization, and real estate)."

Michael Bernard, '85, sends word from Hermosa Beach, Calif: "Since May 1990, I have been working on the Brillant Pebbles Program at TRW as a systems engineer in the Military Space Systems Division. During that time I worked two proposals, managed a technical exhibition, produced four movies, and got more marketing experience than may be healthy! Before that I worked for three years in the Dynamics Department at TRW, involved in passive damping R&D, project work, and proposal management.." . . . **Robert A. Summers**, ScD '54, was incorrectly identified as SM '54 in the last issue. We regret the error.

XVII POLITICAL SCIENCE

Ramon C. Barquin, PhD '74, writes: "Last year I took early retirement from IBM, where my last job was heading the public affairs programs for the corporation Now I am president of the Washington Consulting Group. We do work in aviation, computers, and quantitative studies primarily for the federal government. I've also been very involved with the coalition for computer ethics, which is a group composed of IBM, The Brookings Institution, WCG, and the Washington Technological Consortium." . . . **Lily Gardner Feldman**, PhD '77, a professor of political science at Tufts University since 1978, has been named research director of the American Institute for Contemporary German Studies of The Johns Hopkins University. In her new position, Gardner Feldman will be responsible for overseeing all research conducted at the institute, a national center for the study of contemporary German issues. She will also supervise its academic colloquia, seminars, and conferences, and administer a variety of fellowship programs. . . . **Albert H. Cantril**, PhD '66, has written *The Opinion Connection: Polling, Politics, and the Press* (Congressional Quarterly Press, 1991). According to a news release, the book is "an in-depth analysis of the numerous issues involved in polling today. Cantril brings to pollsters, journalists, scholars, and the politically attentive lay audience an extensive examination of political polling by focusing on its role in the political process, its relationship to the media, and how it serves a larger public purpose."

XVIII MATHEMATICS

Jerrold Grossman, PhD '74, writes: "I have been promoted to full professor in the Department of Mathematical Sciences at Oakland University in Rochester, Mich. My undergraduate textbook in discrete mathematics, published last year by Macmillan, is doing well and is in use at such schools as the University of Maryland." . . . **Gerald Jay Sussman**, '68, Course VI professor at MIT, is the recipient of the Society for Computing and Information Processing's 1990 Karl V. Karlstrom Outstanding Educator Award for "his important contributions to the teaching of computer science." He was cited for "his many research papers that are included in both the undergraduate and graduate curricula, particularly those dealing with his work on contraint-propagation models of electrical networks and nondeterministic pattern-matching implementations of logic programming." Sussman was further cited for his "significant pioneering work in introductory computer science education. Among his extensive contributions are two—the Scheme programming language and the text (cowritten with fellow Professor Harold Abelson, PhD '73 (VI)), *Structure and Interpretation of Computer Programs*—that have helped educators reshape introductory courses."

XX APPLIED BIOLOGICAL SCIENCES

Harmon L. Liebman, SM '54, sends word from Holtwood, Pa.: "We initiated HiQ Services in 1987, just prior to my 'retirement.' It has become a busy little operation doing mostly food process consulting in the dehydration, freeze-drying, frozen, and canned food areas, with some QA/QC work. It keeps the old motor running and is 99% fun work" . . . **Ray Russo**, SM '65, a Plymouth, Mass.-based veterinarian, was the subject of an interview printed in the *Kingston* (Mass.) *Reporter* last March. In the piece he discusses starting up his business and performing one of the first cow caesareans. For over a year, Russo served as Institute veterinarian and instructor at MIT. . . . Gregory Zeikus and **Eric A. Johnson**, ScD '84, are the editors of *Mixed Cultures in Biotechnology* (McGraw-Hill, 1991). "More than a dozen international authorities on mixed cultures have contributed important material on their areas of expertise. They describe the complex characteristics of mixed cultures, investigate the multiple interactions of the microorganisms involved, and explain the principles that affect procedures for either improving existing processes or developing and perfecting new ones," states a press release. Zeikus is the president of the Michigan Biotechnology Institute in Lansing, Mich., and a professor at Michigan State University. Johnson is an associate professor in the Department of Food Microbiology and Toxicology at the University of Wisconsin at Madison.

BY KIMBERLY FRENCH

A Toe in the Door at the White House

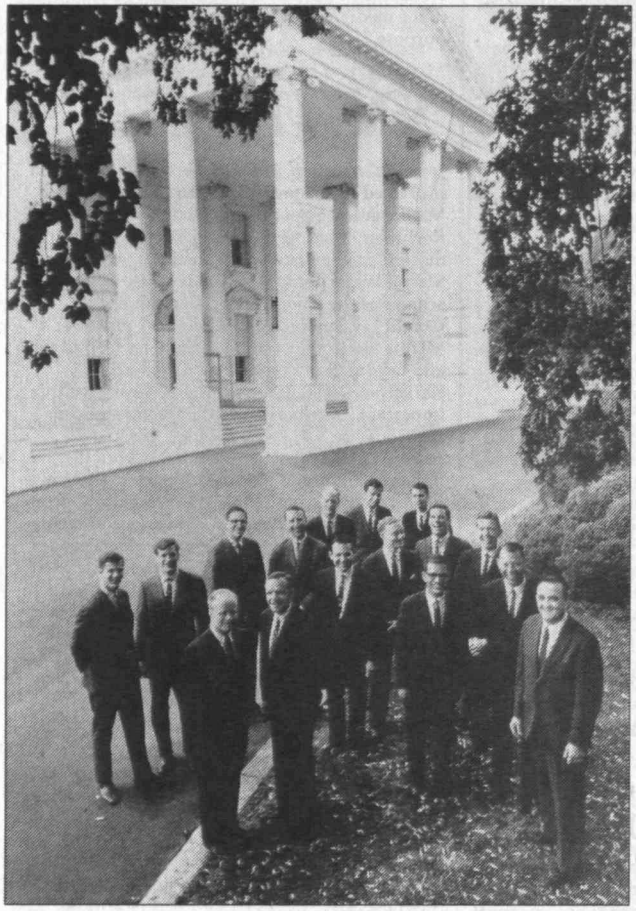
The president of the United States may be one of the most difficult people in the world to get close to, especially if you're young and haven't yet done anything particularly noteworthy. So 25 years ago, President Lyndon Johnson set up a fellowship program that gives a dozen or so promising young people a year-long crash course in statesmanship at the side of the president, his advisors, and Cabinet . The White House Fellows eat in the White House mess, rub shoulders with Supreme Court justices and foreign dignitaries, and get an extremely close look at the inner workings of some branch of the administration.

True, the fellowship does not have the cachet of a Rhodes, Fulbright, or Nieman. "The White House Fellowship program is one of the best-kept secrets in the country," says James A. Fletcher, '67, a former fellow and now vice-president for corporate financial planning and analysis at Unisys Corp. in Bluebell, Pa.

Yet the program has catapulted many of its 350 fellows to some of the highest positions in government, the military, academe, and the private sector. Union Pacific Railroad Co. Chair Michael Walsh, New Mexico Governor Garrey Carruthers, Armed Forces General Colin Powell, and *Los Angeles Times* publisher Tom Johnson were all White House Fellows, and 19 MIT alumni have been fellows over the years.

During their year in the White House, the fellows act as executive assistants to a secretary or high-level advisor—helping with the secretary's schedule, handling paper coming into the office, researching and writing policy proposals, coordinating meetings, and conferring with staff from other Cabinet offices. "The name [White House Fellows Program] is a misnomer," says Walter J. Humann, '59, now chair and president of Hunt Investment Corp. in Dallas. "It's not a graduate program. It's an on-the-job assignment." Fellows are paid as government employees, with a cap of $60,000.

The educational part of the program comes in the form of almost-daily meetings with governors, congressional representatives, mayors, think-tank analysts, business leaders, United Nations officials, minority groups, journalists, and their Cabinet counterparts from foreign countries in leadership roles.



Richard de Neufville, '60, far left, with the first class of White House Fellows in 1965.

For many fellows, the first memories that come to mind are the unusual opportunities high position affords. Richard de Neufville, '60, who was in the first class of fellows in 1965, remembers getting a ride with a Mach-2 test pilot on a visit to McDonnell Douglas. For James Fletcher, the thought of a certain five-course Romanian dinner all the fellows enjoyed on a tour of Eastern Europe still makes his mouth water.

And Walter Humann remembers being in the East Room in 1966, when "a tall individual came up and asked how things were going. It was President Johnson. We had a 20-minute chat about how great Texas was and how to improve the program. He was very wrapped up emotionally with Vietnam. He couldn't go forward and couldn't go backward."

Many of the wunderkinds chosen as fellows later say the experience changed their lives and still shapes their careers. De Neufville, now director of the Technology and Policy Program at MIT, is Exhibit A: "At 25, I was a fairly capable PhD in engineering, but there are thousands of those. There was nothing to suggest I wasn't going to have an ordinary type of career."

As a fellow, de Neufville assisted Defense Secretary Robert McNamara, researching policy issues ranging from the siting of the Hirshhorn Museum on Army property to the release of national illiteracy data from the Air Force Qualifying Exam. After his fellowship year, he returned to research and teaching at MIT and in 1976 launched TPP, which combines engineering and public-policy education.

"What the [White House Fellows] program essentially did for me was give me a sense of obligation to do something for a larger community than myself and put me in the position of creating TPP," he says. "In some ways, TPP is a small thing, a small department at MIT. But it's tapping

PHOTO: NATIONAL GEOGRAPHIC

"We were not seen as people with a long-term bureaucratic self-interest."

some of the best minds and creating a generation of young people that will serve our country in the future. I now hope to have a kind of impact I couldn't have imagined before."

Other fellows report similar career shaping. John N. Hanson, '64, arrived at the White House with a doctorate in theoretical physics. His year as a fellow in the Labor Department crystallized his interest in general management. He is now president of the mining machinery division and a management equity holder at Joy Technologies, Inc., in Pittsburgh.

Fellows do not necessarily become supporters of an administration's policies. As a fellow in the Department of Transportation, Laurence I. Moss, '56, focused on environmental issues such as whether to allow highways to be built through parkland and the viability of the supersonic transport (SST). In 1969, President Richard Nixon decided to go ahead with the development of the SST. Moss and many others in government felt the project should be scrapped because of the inescapable sonic boom, high takeoff noise, and excessive fuel consumption. After his fellowship year, Moss helped organize the Coalition Against the SST, which eventually persuaded Congress to vote against continued funding.

"My interest in the environment was further stimulated by what I learned while I was there," says Moss, who later became president of the Sierra Club and founded Demand Shift Technologies, an Estes Park, Colo., company that makes equipment to shift electricity loads to off-peak hours. He has been active in a number of environmental fights, such as keeping dams out of the Grand Canyon and suing the Environmental Protection Agency to force it to protect air quality in clean-air regions.

Like Moss, James Fletcher says his fellowship year made him realize the necessity of focusing on grass-roots involvement and avoiding "Potomac fever." "My interest was concern with poverty programs, civil rights, and the empowerment of people who have no power," says Fletcher, who represented the Office of Management and Budget on a welfare-reform task force during his fellowship year and also wrote the minorities section for another task force on the new federalism. "I saw how difficult it is for poor and powerless people—and a large part of the middle class—to have a real voice in Washington."

Fletcher's class of fellows visited several African countries. Since then he's made three more visits to South Africa, where he recently broke ground on a community center in Soweto that will offer day care and adult education. He had to combine the support of corporations such as Unisys with religious groups such as the Quakers to make the center acceptable to the apartheid government, which has looser restrictions for religious institutions.

"The program cultivated a sense of civic duty among those people who would claim to be leaders of the people," he says. "We tend to think too much about our own private pursuits in the private sector and not enough about public problems and how urgent those are."

The lack of emphasis on the public good in the private sector is a concern many fellows share. "The fellowship gave me a stronger sense," Humann says, "that all of us private citizens ought to bend over backward to help government officials instead of accusing them of not being able to solve problems. A lot of times we're responsible for creating those problems."

Adds Ronald Baukol, SM '60, now group vice-president for medical products at 3M Corp. in St. Paul, "It made me more sympathetic toward policymakers and less sympathetic toward interest groups."

The complexity behind policy decisions makes it difficult to understand government through media reports, comments Martin Jischke, PhD '68, who was recently named president of Iowa State University. "Superficially it can seem as if people aren't making the right decision or handling things well," he says. "But well-informed, honest, honorable people can genuinely disagree substantively on public-policy issues, which makes decision making very complex and tortuous. Compromise must take place, and it's not simple, clean, or direct."

As a fellow, Jischke worked in the Department of Transportation researching passive-restraint systems in automobiles. The issue raised a number of questions about the role of the federal government as well as the cost and effectiveness of passive restraints. "This gets to the heart of federal policy. The law in this case raises questions about reasonableness and feasibility." After much study and lab testing, the Ford administration decided to field-test 500,000 cars, a decision the next administration rescinded. "It's been tied up ever since—another lesson about one's impact in federal government," Jischke says. "Every four years a new administration can come in and change everything."

But the fellows do believe that they can change the nature of policy discussions, in part because of their short-term commitment—something that the program's conceivers may not have foreseen. "All the fellows got together as a group about once a day," recalls Robert Huefner, MCP '60, now chair of the political science department at the University of Utah in Salt Lake City. "It meant that we ended up with a very close linkage, and it created a group of connections across departments that was quite unusual. We were not seen as people with a long-term bureaucratic self-interest. It was easy to talk with each other on a trusting basis and easy to talk with our contacts in our departments. It made for a very open and usable network, and we used it quite a lot."

During his fellowship year, Huefner worked in the Treasury Department, researching tax questions such as the reform of income-tax deductions and whether the federal government was better off making municipal bonds tax-exempt or giving aid to municipalities in the form of grants. He remembers discussing with his counterparts in the Transportation and Housing & Urban Development departments how they might use the bond and capital markets to finance projects. "It substantially broadened the nature of the discussions within those departments," he remembers. "I was able to connect them with the right people and help them understand how things worked in Treasury so they could better consider financial strategies."

Though the number of fellows over the past 25 years is only a few hundred, the fields they cover are quite broad, points out Randy Jayne, PhD '69, now president of McDonnell Douglas Missile Systems Co. "If somebody asks me a question about banking or international trade or computers, chances are there's somebody I know from that network of fellows who can help." □

KIMBERLY FRENCH is a freelance writer and frequent contributor to Technology Review.

1902-1991

William C. Greene

Professor Emeritus William C. Greene, a member of the humanities faculty for 41 years, died on February 21 at the age of 89. During his 41-year career at MIT, he taught some 25 different subjects to more than 6,000 students. He strove to demonstrate that literature and the other arts were more than tangential to the lives of students chiefly interested in technology.

Greene was also secretary of the faculty from 1964–66, serving ex officio as chair of the Committee on Academic Performance. In this post he sought to strengthen counseling activities for students, for which he received the 1965 Billard Award for outstanding service to the student community.

In addition to teaching and writing, Greene was active in a number of campus organizations. For many years he was a central figure in Tech Show, an annual student-written musical comedy. During the last weeks before opening night, he sometimes spent as many as 30 hours a week as advisor, helping to polish the final script. He was also involved with Dramashop and the Community Players and developed skits that sometimes evolved into full-length musical parodies.Greene began at MIT as an instructor in English in 1925 and was named a full professor in 1948. He spent his entire career at MIT ex cept for a year at Stevens Institute of Technology on an exchange basis. In the 1930s he wrote a novel, *A Deeper Root*, based on his own family's history in New England. He also wrote a book of criticism, *The Choices of Criticism* (MIT Press, 1965), based on a series of lectures he had given. Following his retirement he wrote a collection of autobiographical poems, *Nodes on a Long String*, that was privately published. He was an accomplished painter in both watercolor and oil. Greene's wife, Harriet Howe Greene, a retired faculty member at Pine Manor College, died on February 7.

Speaking at Greene's memorial service, MIT Professor of History Richard Douglas said, "As I prepare to speak today I imagine Greene's warning: Keep it short, stay to the facts, and don't get fancy." Douglas sees that statement as the epitome of the man. He remembers Greene as a "crisp, laconic Yankee who was a plain talker." Douglas says that Greene was best at tutorial teaching: "like a lawyer he asked question after question and created great exchanges between students and himself." □

XXII NUCLEAR ENGINEERING

Achilles G. Adamantiacles, PhD '66, sends word from Bethesda, Md.: "I have been a senior power engineer for the World Bank for the past three years. My work covered energy development and power projects in Brazil, Pakistan, Jordan, India, and Cyprus. I am currently working on World Bank loans to Poland, Romania, and Czechoslovakia aimed at the rehabilitation of power systems and the amelioration of environmental conditions. I am also task manager of a group addressing nuclear power issues with emphasis on the safety of Soviet-designed nuclear power reactors." . . . **Robert W. Davis**, NUE '80, writes from Manhattan Beach, Calif.: "I am employed by TRW, Inc., in the Space & Technology Group, where I am program manager. We work on systems engineering and conceptual design of new space systems. We are currently leading a six-corporation team pursuing over $350 million in sales." . . . **Patrick M. Hogan**, SM '89, reports: "I am currently working in the Licensing Group of ABB Impell Corp.'s midwest region in Chicago, Ill." . . . **John W. Keffer**, SM '88, writes: "I am working as a BWR Nuclear Designer for Commonwealth Edison Co. in Chicago. Also, I am involved with the Education Committee of the A.N.S. Chicago Section. Pamela and I are planting trees around our house in Naperville."

Lieutenant **Mat Waltrip**, SM '89, USN, writes: "I have completed qualification in submarines and am assigned to Mare Island Naval Shipyard in Vallejo, Calif. My present project is working as nuclear ship superintendent on the USS *Salt Lake City* (SSN-716). We are making preparations for reactor plant improvements to be performed during a Depot Modernization Period. I celebrated my first wedding anniversary on June 2. My wife Ellen is a New England gal I met while attending grad school at MIT. . . . **Jim Robinson**, PhD '85, reports: "I have joined BP Exploration in Houston, Tex. My current projects include a study of multiphase flow effects in wellbore and expert system applications to welltesting." . . . From Paris, **Eric Sasson**, SM '87, writes: "INSEAD (Fontainebleau) and my MBA are now behind me and I'm starting to work for a French building & construction company called SINVIM, part of Compagnie Bancaire group (main stockholder: Paribas). I'll be in charge of many European projects and I'm the first MIT alumnus in this company. After 10 months of marital life, I still enjoy bringing Carine her breakfast in bed. MIT and Boston are now four years old in my memory but still vivid." . . . **Elia P. Demetri**, SM '62, is technology manager at Herzog-Hart Corp. in Boston. Demetri was director of R&D for Advanced Mechanical Technicians, Inc., in Newton, Mass.

Deceased

The following deaths have been reported to the Alumni/ae Association since the *Review* last went to press:

Benjamin F. Lapp, '15; March 23, 1991; Walnut Creek, Calif.
George Henry Atkinson, '21; January 27, 1991; Copley, Ohio.
Alfred Clarence Garrigus, '21; March 31, 1991; Attleboro Falls, Mass.
Frederick H. Untiedt, '22; January 11, 1991; Chevy Chase, Md.
Neil Alexander MacNeil, '23; April 10, 1991; Holyoke, Mass.
Chester P. Currier, '25; March 31, 1991; Worcester, Mass.
J. Fred Buenz, '26; March 8, 1991; San Antonio, Tex.
F. Spaulding Dunbar, '26; April 14, 1991; Chatham, Mass.
Morris L. Minsk, '26; March 13, 1991; Chelsea, Mass.
Edward N. Roberts, '26; August 9, 1990; Jacksonville, Fla.
Edmund H. Burke, '27; March 19, 1991; Newburyport, Mass.
William F. Fitzgerald, '27; April 8, 1991.
Maurice Coffyn Holmes, '27; March 16, 1991; Homestead, Fla.
Frederick B. Lewis, '28; April 21, 1991; Arlington, Mass.
George James Guthrie Nicholson, '29; April 2, 1991; Thermopolis, Wyo.
Louise W. Dingwell, '30; March 17, 1991; East Providence, R.I.
Robert K. Whitten, '30; March 27, 1991; East Dennis, Mass.
George A. Chapman, '31; March 5, 1991; Pacific Grove, Calif.
William C. Lamb, '31; November 9, 1990; Tequesta, Fla.
Robert Dillon, '33; November 11, 1990; La Marque, Tex.
George M. Green, '33; April 14, 1991; Stockbridge, Mass.
Gordon Powers, '34; April 4, 1990; Tequesta, Fla.
Edward Rickard, Jr., '34; March 24, 1991; Brevard, N.C.
Bernard H. Nelson, '35; March 22, 1991; Wellesley, Mass.
Ronald D. Eames, '36; March 20, 1991; Weston, Mass.
Philip B. Grant, '36; March 17, 1991; North Windham, Maine.
Clinton J.T. Young, '36; March 30, 1991; Alexandria, Va.
John C. Gibbs, '37; May 11, 1989; Las Vegas, Nev.
Leo Rosen, '37; March 16, 1991; Falls Church, Va.
Robert William Morgan, '38; January 19, 1991; Denver, Colo.

We are happy to report that **Harry G. Steinman**, '33, is not deceased as was erroneously reported in the February/March issue, page MIT 19. Our apologies for any distress this may have caused.

Going Out on a LYM

I continue to receive lovely letters concerning the return of "Puzzle Corner." Thank you all. We are out of chess-, computer-, and go-related problems. If you wish to see them, send them.

Problems

A/S 1. We begin with a bridge problem from Don Boynton, who needs to make 7 hearts against any defense with an opening lead of the queen of clubs.

North
♠ 2
♥ 3 2
♦ A K 2
♣ A K 7 6 5 4 3

West	East
♠ K 10 8	♠ 7 6 5 4 3
♥ 5	♥ Q 10 8 7
♦ Q J 10 9	♦ 8 7 6
♣ Q J 10 9 8	♣ 2

South
♠ A Q J 9
♥ A K J 9 6 4
♦ 5 4 3
♣

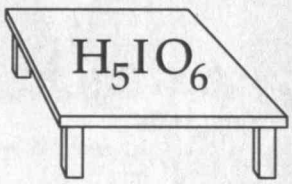
A/S 2. Thomas Weiss wants you to find a crossword puzzle using as few squares as possible but satisfying:
(1) All 26 letters of the English alphabet are used at least once each.
(2) No proper nouns, abbreviations, contractions, acronyms, or foreign words are used.
(3) All letters are used to form words both horizontally and vertically.
(4) Radial symmetry about the center is achieved, as is common in American crossword puzzles.

A/S 3. Our last regular problem is from Nob. Yoshigahara. Choose two digits excluding 0 and 1 and consider the set of numbers that contain each of the two digits at least once. For example, 4 and 8 gives 8848, 4884, 84 and infinitely many others. Now consider the smallest member of this set that is a multiple of the two original digits. Call this the LYM (least Yoshigahara multiple). In our example the LYM is 48; the LYM of 3 and 5 is 3555. Among the 28 pairs of digits, 4 lead to sets that do not contain a multiple of the digits and, for these pairs, the LYM is not defined. For example, all multiples of 2 and 5 end in 0 so are not in the set constructed from 2 and 5. The LYM of 2 and 4 is 24, which is the smallest of the LYMs. What is the largest?

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO:
ALLAN J. GOTTLIEB, '67
THE COURANT INSTITUTE
NEW YORK UNIVERSITY
251 MERCER ST.
NEW YORK, N.Y. 10012, OR TO:
gottlieb@nyu.edu

Speed Department

What would you call



Solutions

APR 1. As mentioned last issue there was an unfortunate typo in the problem as stated in April. The corrected problem was printed as M/J 1.

APR 2. Warren Himmelberger sent us an old chestnut (really old coconut) involving a monkey and some monkey business. In addition to the original problem, which is given below, Himmelberger suggests some interesting generalizations. Anyone interested in these extensions should write to Faith Hruby at *Technology Review* and ask for a copy of Himmelberger's Feb. 1973 article from the *Mathematics Teacher*.

Four men are going to divide a pile of coconuts equally the following day. But, during the night, the first man decides to take his share secretly. He divides the coconuts into four piles, finds there is one nut left over and gives it to the monkey. He takes his share and puts the other three shares back. The second, third, and fourth man, in turn, proceed to do the same thing, each giving his share, and returning the other three shares to the pile. Then, in the morning, the four men meet to divide the remaining nuts into equal shares, and find there is again one nut left for the monkey. The puzzle is to find the least number of nuts in the original pile.

Mary Lindenberg reports a strange coincidence concerning this problem:

An "Ask Marilyn" column in *Parade* magazine this past March included the piles of coconuts problem—and the very next day I received the April *TR* with an expanded version of the puzzle! My answer:

Let C = the total number of coconuts, then let C_1 = the number of nuts the 1st thief steals,
C_2 = the number of nuts the 2nd thief steals,
C_3 = the number of nuts the 3rd thief steals,
C_4 = the number of nuts the 4th thief steals, and
C_5 =the number of nuts the 5th thief steals. Then $C = 4C_1 + 1$; $3C_1 = 4C_2 + 1$; $3C_2 = 4C_3 + 1$; $3C_3 = 4C_4 + 1$; and $3C_4 = 4C_5 + 1$. By substituting the last equation in the one preceding it, and continuing this way we get

$$C = \frac{1024C_5 + 781}{81} = 12C_5 + 9 + \frac{52(C_5 + 1)}{81}.$$

For C to be an integer, C_5 has to be at least 80. So the least number of nuts in the original pile has to be $C = 12(80) + 9 + 52 = 1021$.

Several readers gave solutions for larger numbers of men and James Abbott notes that Martin Gardner's *2nd Scientific American Book of Mathematical Puzzles and Diversions* also discusses the general problem. Gardner's column ran for decades in *Scientific American*. Indeed, it was only after he stepped down that I considered my tenure at *Technology Review* to be of significant duration.

APR 3. Stephen Callaghan proposes the following problem. It looks difficult to me but I have been proven wrong in this regard before! You are to find the number of ``distinct'' mxm matrices with n<m 1s and m-n 0s in each row and column. Two matrices are considered equivalent (i.e. not distinct) if one can be converted to the other by permuting the rows and the columns. As an example, for m=4 and n=2, the following two matrices are distinct.

1100	1100
1100	1010
0011	0101
0011	0011

Looks like I was right! The only response was from Bob High who notes a similarity with problem E3419 in the January 1991 *American Mathematical Monthly*. High has determined that when n=2, the answer is the same as the number of partitions of m into pieces all of size at least 2.

Other Responders

Responses have also been received from J. Abbott, A. Apter, R. Bart, F. Carbin, D. Church, S. Feldman, M. Gennert, M. Gilman, J. Grossman, W. Hartford, R. Hess, M. Lively, R. Marks, A. Ornstein, P. Rakita, K. Rosato, N. Spencer, A. Taylor, N. Wickstrand, W. Woods, D. Young, and H. Zaremba

Proposer's Solution to Speed Problem

Periodic table.

MIT LIFE INCOME FUNDS

PROFESSOR ALBERT G.H. DIETZ

HOME: Winchester, Massachusetts

CAREER: Professor Dietz got his start working for his father, a housebuilder, during summers and holidays. He earned an S.B. at MIT in building engineering and construction in 1932 and later a master's and doctorate in properties of materials. He then joined the MIT faculty and taught building technology in the departments of building engineering and construction, civil engineering and finally architecture. His research has been primarily in the use of plastics in building (he founded MIT's interdisciplinary plastics research laboratory), building methods and materials, and solar energy.

Named "Construction Man of the Quarter Century" by the National Academies of Science and Engineering, Professor Dietz has received awards from around the world. Among the works he has enjoyed the most are his engineering design of the Monsanto House of the Future in Disneyland; his work on the pavilions at the American Exhibition in Moscow; his studies of housing needs in Central and South America, Pacific areas and Southeast Asia, and of industrialized housing for the USSR, Europe and Japan; and rescuing and restoring priceless Florentine frescos damaged in the disastrous 1966 flood. He has written extensively; the fifth edition of his 1946 text book *Dwelling House Construction* was published this year by the MIT Press.

He and his wife Ruth, who have been married for 55 years, have two children and three grandchildren. His hobbies include travel, 3-D photography, swimming, building furniture and reading.

GIFT OF CAPITAL: The Albert G.H. Dietz (1932) Fund in the Maclaurin Pooled Income Fund.

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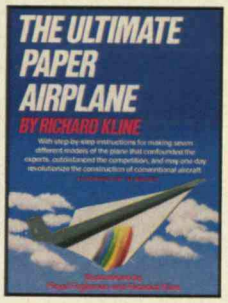

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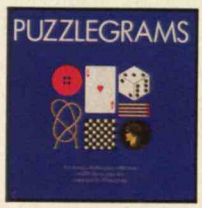

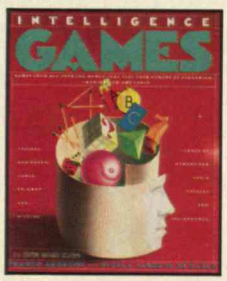

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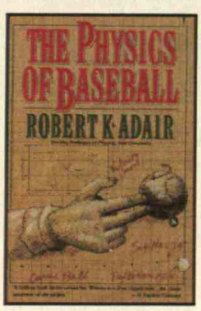

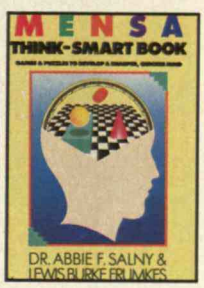

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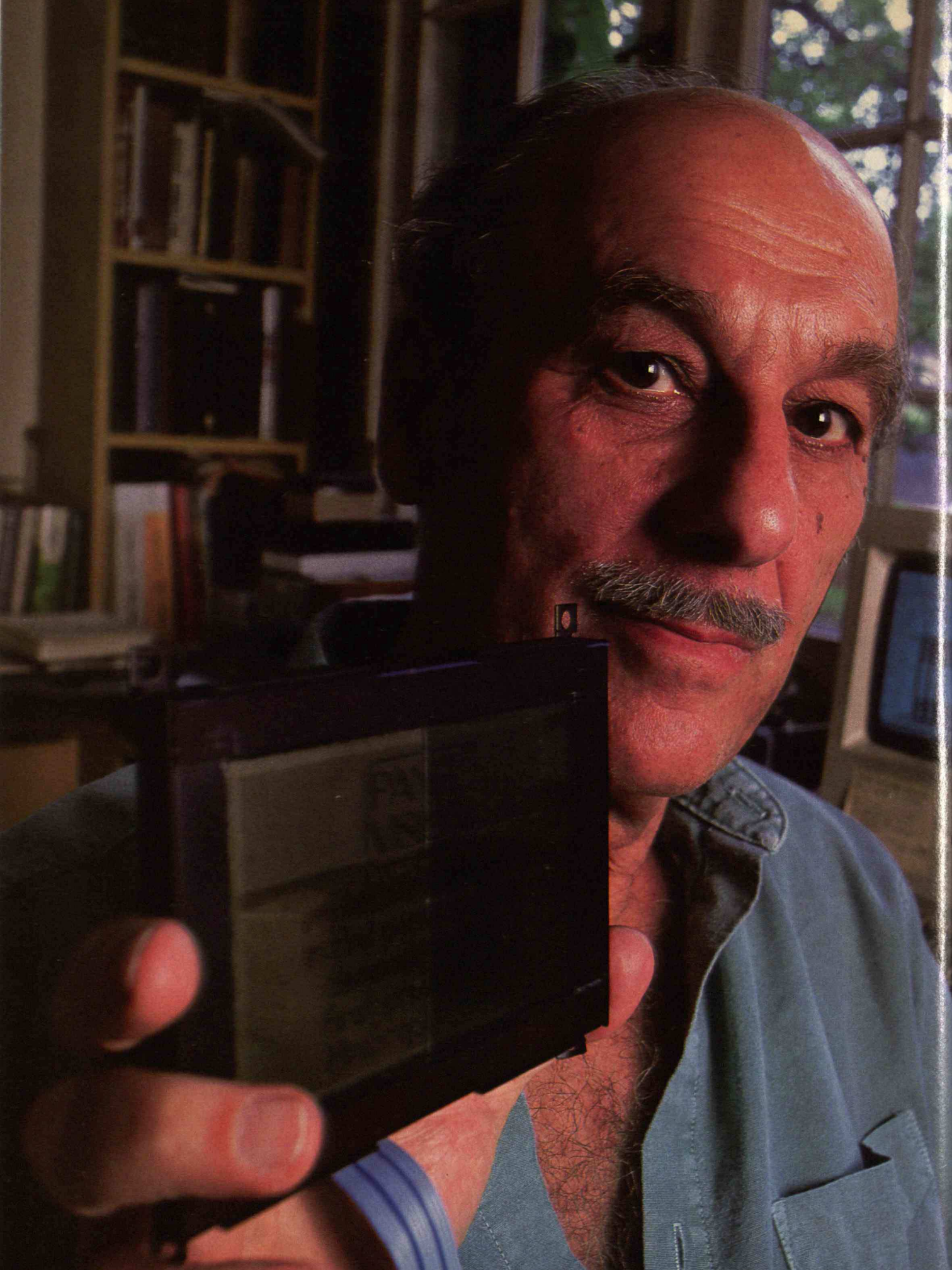


The Invention that Got Away

LAST spring, portable computers with a new kind of display technology began to roll off production lines. In contrast to the sometimes cloudy displays on conventional laptop computers, these lightweight color screens rival high-quality desktop monitors in brightness and clarity. This new kind of display will eventually appear in myriad products, including a TV set that you will hang on the living room wall or fit in a briefcase. These displays will come from a variety of companies—every one of them Japanese. But the technology that makes these displays possible was invented in the United States.

The loss of this display technology reveals fundamental weaknesses of the U.S. high-technology system. Not only did our large corporations lack the vision and the persistence to turn this invention into a marketable product, but the venture capital financiers, who made possible such high-technology industries as semiconductors and personal computers, failed too. Neither large nor small firms were able to match a dazzling innovation with the manufacturing muscle needed for commercial production. As a result, a vital technology developed in the United States slipped away.

By failing to capitalize on Peter Brody's "active-matrix" display technology, the U.S. handed the Japanese another electronics monopoly.

BY RICHARD FLORIDA AND DAVID BROWDY

T. Peter Brody holds a 1983 prototype of a display using his active-matrix technology. Brody has spent much of the past 20 years trying to interest U.S. high-tech companies and investors in his invention, which could eventually replace the bulky cathode-ray tubes used in virtually all of today's TVs and computers.

PHOTOGRAPH: L. BARRY HETHERINGTON

New laptop computers like Sharp's Colorstar use active-matrix technology to provide color displays rivaling those of desktop computers.

This case suggests that the United States is beginning to pay the price for the entrepreneurial "renaissance" of the 1980s. More than 100,000 high-technology companies were launched during that decade. The venture capital pool surged from less than $5 billion to more than $30 billion. Silicon Valley and Route 128 were held out as examples of the benefits of freewheeling entrepreneurship fed by venture capital. Management gurus, business consultants, and academics sang the praises of this vigorous form of industrial development.

But high-technology entrepreneurship has not worked as well as envisioned. In technology after technology, our small venture capital–backed firms are falling prey to large foreign competitors, most of them Japanese. In fact, it has become clear that the small start-ups suffer from many of the same structural and organizational weaknesses that plague our stodgy corporate behemoths.

Nowhere is this phenomenon more striking than in the area of flat-panel displays. An important element of the new generation of displays is a technology called active matrix, which uses advanced microelectronics techniques to produce brighter, sharper images than previous units. (*see the sidebar on page 45*). Active-matrix technology will replace the bulky cathode-ray tubes (CRTs) that inhabit today's televisions and computer monitors. It will thus drive many of the emerging electronics markets of the twenty-first century.

Today's small-screen flat-panel displays are used mainly in laptop computers and cockpit displays. But future uses include medical imaging systems, teleconferencing, automobile dashboards, and even readouts for traditional home appliances. Larger displays are likely to be a principle component of the multibillion-dollar market for high-definition television. Flat-panel displays will be, in a word, everywhere. Worldwide sales already exceed $4 billion (up from $2.4 billion in 1988), and they are projected to reach $14 billion by 1997.

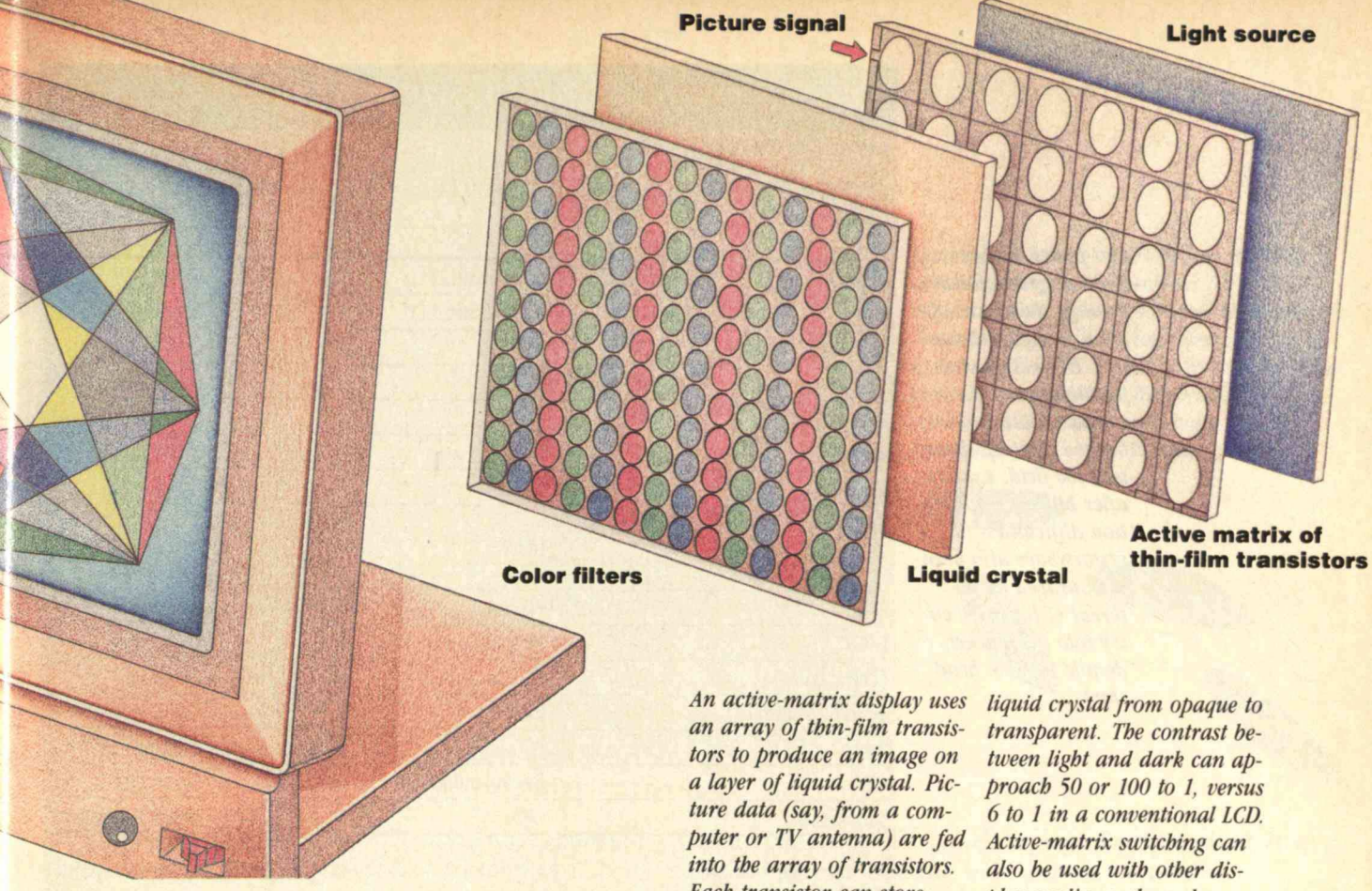
Over the past two or three decades, the U.S. companies that invented and incubated the technology have squandered a seemingly insurmountable lead. Japan now owns 98 percent of the world market for flat-panel displays and virtually 100 percent of the market for those using active-matrix technology. For the United States, this is a case not just of declining competitiveness but of near total annihilation in a key electronic technology.

The story of how this invention got away reveals a typical pattern. A large company, in this case Westinghouse, was unwilling to gear up for the high-volume production required to turn a new technology it had invented into a commercial success. And in contrast to the popular picture of creative technologists reaching their goals once they break free from corporate bureacracies, entrepreneurs and venture capitalists were unable or unwilling to jump in and save the day. Like Westinghouse, the venture capital–backed start-ups failed to develop the needed production capabilities.

But this is more than another dreary tale of indus-

RICHARD FLORIDA is associate professor of management and public policy at Carnegie-Mellon University's School of Urban and Public Affairs. He is coauthor (with Martin Kenney) of The Breakthrough Illusion: Corporate America's Failure to Move from Innovation to Mass Production *(Basic Books, 1990) and of* Technology Review*'s February/March 1991 cover story on Japanese factories in the U.S. Rust Belt. DAVID BROWDY administers research programs at the Institute for Mathematics and Science Education at the University of Illinois in Chicago. He holds a master's degree from Carnegie-Mellon's collaborative program in private and public management policy.*

ILLUSTRATIONS: MARY ANNE LLOYD



An active-matrix display uses an array of thin-film transistors to produce an image on a layer of liquid crystal. Picture data (say, from a computer or TV antenna) are fed into the array of transistors. Each transistor can store enough voltage to quickly switch a spot on the back-lit liquid crystal from opaque to transparent. The contrast between light and dark can approach 50 or 100 to 1, versus 6 to 1 in a conventional LCD. Active-matrix switching can also be used with other display media, such as electroluminescent panels.

What Is an Active Matrix Design?

In any electronic display, signals are converted to points of light in patterns that form images. An active matrix is basically a better way to deliver these signals to the display medium.

In a conventional flat-panel display, such as the type used on today's laptop computers, picture information reaches the screen via rows and columns of electrodes. The intersections of these electrodes form a grid of picture elements, or pixels. The pixel at a particular crosspoint turns on only when a voltage is present in both the row and the column electrode.

This technique, known as multiplexing, works adequately for small displays, but even there the image is far less crisp than on a cathode-ray tube (CRT). The more pixels there are, the poorer the image. That's because the voltage coursing through all those electrodes permeates the liquid crystal—the medium that turns from light to dark in response to a voltage—so even pixels that are supposed to be off get turned slightly on. The result is lower contrast: instead of crisp black and white, the image appears in barely distinguishable shades of gray.

Multiplexing also makes liquid crystal displays inadequate for displaying moving images. The response time of a liquid crystal display is proportional to the voltage applied. Since multiplexing limits the voltage that can be applied, the conventional liquid crystal display is unable to show moving pictures with the sharpness of a cathode-ray tube.

The active-matrix design avoids these problems by placing a separate semiconductor switch—a thin-film transistor, or TFT—at each pixel. The TFT can transfer and store enough voltage to quickly switch a liquid crystal pixel from light to dark, resulting in a sharp image with no blurring. With the TFT active matrix, the electric charge used to switch one pixel no longer spills over into neighboring ones. As a result, the contrast between an on and an off pixel can approach 50 or 100 to one—versus six to one in a typical multiplexed LCD. And because the TFTs are deposited on a transparent glass substrate, the display can be lit from behind, further enhancing its viewability. Red, green, and blue filters can be placed at each pixel to form a color display. Because of its high contrast capability, an active-matrix display can produce full color images that look as good as or better than those produced by CRTs.

—Herb Brody ■

DIAGRAM: DAN COLLINS

Flat-panel display technology has fallen through the cracks of the U.S. high-tech system. Both large corporations and venture capital–backed start-ups have quit the field, usually after hitting production difficulties. Investors have also been discouraged by the threat of Japanese entry into the market, despite the U.S. head start.

THE SHRINKING U.S. EFFORT IN FLAT-PANEL DISPLAYS

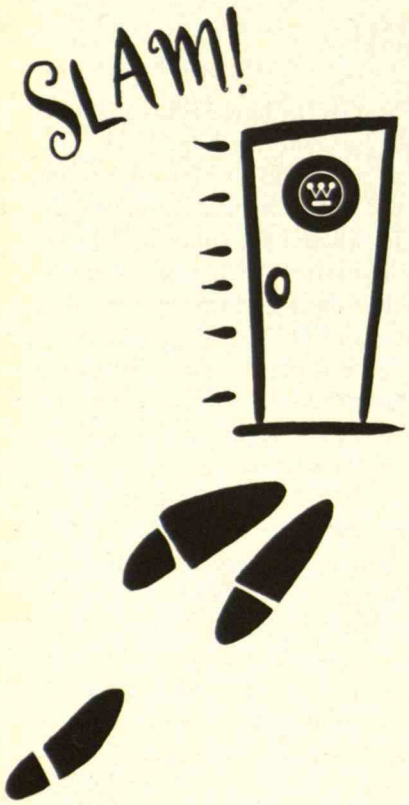
LARGE CORPORATIONS

COMPANY	TECHNOLOGY	STATUS OF FLAT PANEL DISPLAY WORK
Westinghouse	Active-matrix LCD	Closed 1979
RCA	Active-matrix LCD	Closed 1970s
GE	LCD	Sold 1989
IBM	Plasma	Sold 1987
Owens-Illinois	Plasma	Closed 1970s
Hughes	Various	Closed 1970s
Raytheon	Various	Closed 1970s
Exxon		
EPID/Exxon	Other	Closed 1986
Kylex/Exxon	LCD	Sold 1983
AT&T	Plasma	Closed 1987
NCR	Plasma	Closed 1984
Control Data	Plasma	Closed 1980
Texas Instruments	Plasma	Closed 1983
Xerox	LCD	Ongoing research
GTE	Electroluminescent	Closed 1987
Sarnoff Labs	LCD	Ongoing research

START-UPS, SMALL COMPANIES

COMPANY	TECHNOLOGY	STATUS	ORIGIN
Panelvision	Active-matrix LCD	Sold 1985	Westinghouse
Magnascreen	Active-matrix LCD	Ongoing R&D	Westinghouse
Alphasil	LCD	Closed 1988	—
Cherry	Electroluminescent	Small-scale production	European tech.
Coloray	Other	Seeking funding	—
Crystal Vision	LCD	Closed 1984	—
Electro-Plasma	Plasma	Small-scale production	Owens-Illinois
LC Systems	LCD	Closed 1988	—
Optical Imaging Systems	LCD	Ongoing R&D	Westinghouse, GE
Photonics	Plasma	Small-scale production	Owens-Illinois
Planar	Electroluminescent	Small-scale production	Tektronix
Plasma Graphics	Plasma	Closed 1985	Burroughs
Plasmaco	Plasma	Small-scale production	—
Sigmatron Nova	Electroluminescent	Closed 1988	—
Tektronix	LCD	Ongoing R&D	—

SOURCES: U.S. Congress Office of Technology Assessment; interviews by authors



Japanese Investments in Display-Making Factories

COMPANY	INVESTMENT ($ MILLIONS)	TECHNOLOGY	START DATE
Sharp	700	Active-matrix LCD	1993
Sanyo	560	Active-matrix LCD	1992
Matsushita	350	Active-matrix LCD	1991
Hitachi	210	Active-matrix LCD	1991
Seiko-Epson	167	Active-matrix LCD	NA
Hoshiden	140	Active-matrix LCD	NA
Toshiba/IBM	140	Active-matrix LCD	1991
Fuji-Xerox	80	Active-matrix LCD	1992
Mitsubishi	70	Active-matrix LCD	NA
NEC	70	Active-matrix LCD	1992
Alps	33	Active-matrix LCD	1992
Sharp	30	Passive LCD	1992
Seiko Instruments	20	Diode matrix	NA

SOURCES: U.S. Congress Office of Technology Assessment; Japan-U.S. Business Report; interviews by authors

Japanese computer and electronics makers are rushing into the void left by U.S. industry. Even U.S. computer companies are buying their displays from Japan: Hoshiden supplies screens for Apple's portable Macintosh, and Sharp makes the displays used in Texas Instruments' notebook-size computer.

try's failure. It is also the story of one scientist's unrelenting crusade to bring his invention to market.

Found and Lost at Westinghouse

In the early 1960s, Westinghouse was a leading producer of televisions and semiconductors, and it focused a significant part of its R&D on developing new technologies in both fields. In semiconductors, for example, Westinghouse engineers began to explore new devices that would be simpler, smaller, and easier to manufacture than traditional transistors.

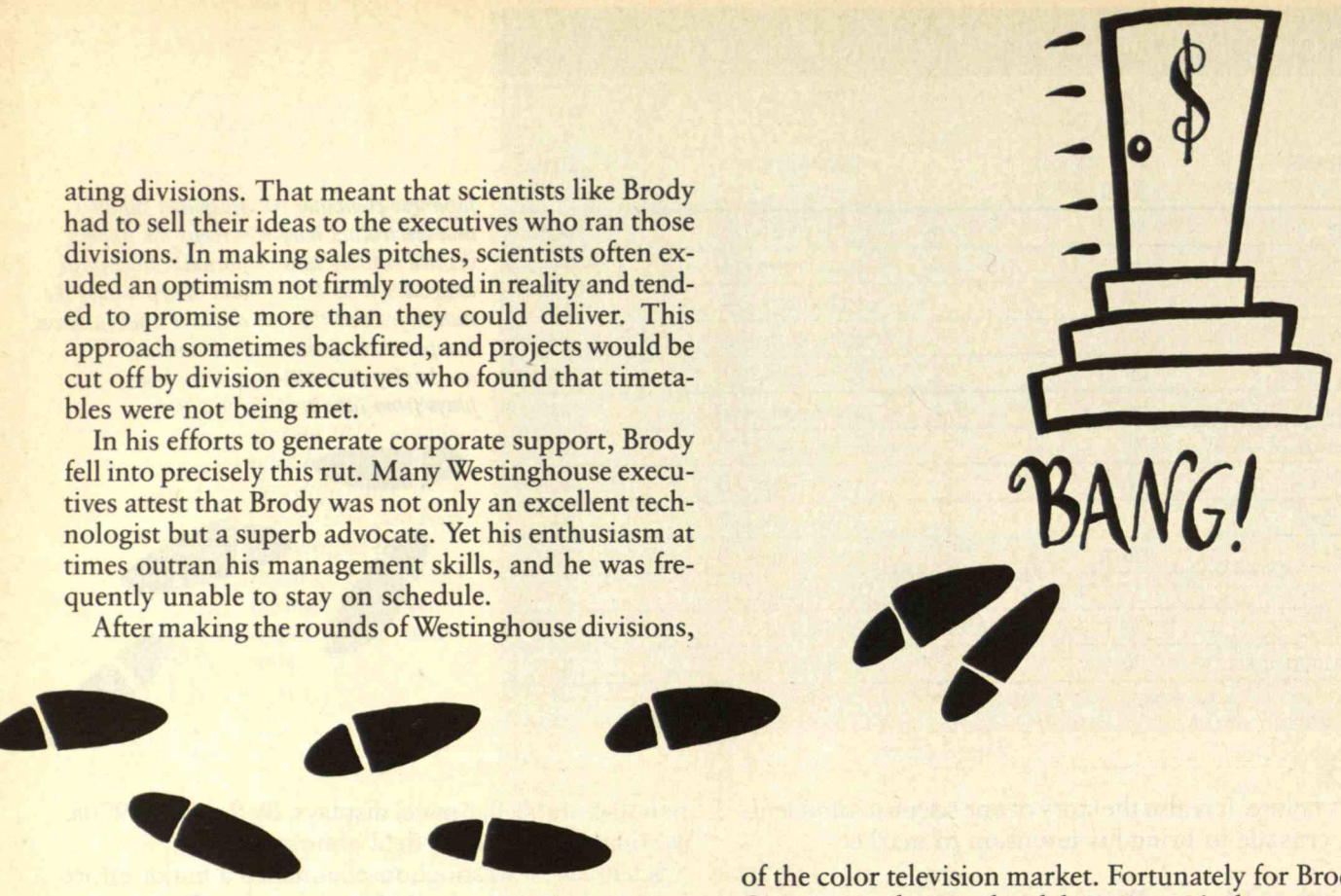
One promising class of devices was thin-film transistors. Unlike conventional transistors, thin-film devices can be fabricated in arrays that can cover large areas. It gradually became evident that one of their most revolutionary applications was in flat-screen television displays, or what Westinghouse executives came to call "the screen on the wall." Thin-film transistors might make practical an active-matrix liquid-crystal display (LCD) superior to the LCDs then being produced. An active-matrix display works like a large semiconductor memory chip. Picture data are written on the screen in the same way that bits are written onto a memory chip.

Westinghouse was not alone in these early days of flat-panel display development. RCA had large-scale efforts in both thin-film technology and flat-panel displays. Other companies—including General Electric, Hughes Aircraft, Raytheon, Zenith, Burroughs, Owens-Illinois, and IBM—were also active in the field. But most of them abandoned their efforts when they failed to come up with a way to produce inexpensive, manufacturable flat-panel displays. By the early 1970s, Westinghouse had the field almost to itself.

Scientists at Westinghouse launched a major effort to create active-matrix displays using thin-film transistors. The R&D team was headed by T. Peter Brody, a Hungarian-born scientist who had come to Westinghouse to build what he hoped would be the world's leading thin-film transistor research group. As group leader, Brody wrote some important technical papers on the subject. He received some support early on from Westinghouse's semiconductor unit in Youngwood, Pa., and later from the molecular electronics division in Baltimore.

By the mid-1960s, Westinghouse's semiconductor efforts were faltering under the weight of competition from companies such as Texas Instruments, Motorola, and Fairchild. Under mounting pressure from central corporate management to turn a profit, Westinghouse's molecular electronics division turned away from thin films and focused on improving conventional transistors. And as the company's semiconductor units began to lose money, they were less able to sponsor R&D like Brody's thin-film work. They gave it only tenuous support, regarding it as a quixotic attempt to reinvent a wheel that already rolled smoothly. In 1967, top Westinghouse management gave Brody three months to get funding from other divisions or face the axe.

This ultimatum reflected a corporate funding structure that proved more problematic for Brody than technical opposition. At Westinghouse in the 1960s and 1970s, as at most big companies of the era, R&D groups were required to generate funds from the oper-



ating divisions. That meant that scientists like Brody had to sell their ideas to the executives who ran those divisions. In making sales pitches, scientists often exuded an optimism not firmly rooted in reality and tended to promise more than they could deliver. This approach sometimes backfired, and projects would be cut off by division executives who found that timetables were not being met.

In his efforts to generate corporate support, Brody fell into precisely this rut. Many Westinghouse executives attest that Brody was not only an excellent technologist but a superb advocate. Yet his enthusiasm at times outran his management skills, and he was frequently unable to stay on schedule.

After making the rounds of Westinghouse divisions, Brody got several to sign on in support of the thin-film transistor research. (In the interim, he received military contracts to keep his work going.) At Westinghouse, his biggest supporters were the consumer electronics division and the electron tube division. Consumer Electronics was a large and powerful organization with a long history in radios, televisions, and home appliances. The division saw flat-panel displays as a way for Westinghouse to gain ground on RCA and others in the television business, where Westinghouse was losing market share.

The plan was to make the elusive TV-screen-on-a-wall. William Coates, then an executive in Consumer Electronics, became Brody's champion. From the mid-1960s to the early 1970s, the division pumped millions of dollars into his work. "We were a hundred miles ahead of anybody," recalls Coates, who says he believed that Brody's work "was going to make Westinghouse."

In contrast to the technological parochialism at Westinghouse's semiconductor units, Consumer Electronics had no qualms about Brody's use of thin-film transistors. "We could care less about what technology he used," says Coates. "If he could make us a flat screen that was going to cost less than a cathode-ray tube—wow!"

Brody's effort suffered a major blow in the early 1970s, when Westinghouse decided to stop making televisions. The company had seen its market share dwindle to 3 percent of the black-and-white and 1 percent of the color television market. Fortunately for Brody, Coates moved over to head the company's electron tube division, which continued to make replacement picture tubes for Westinghouse TVs and to supply other manufacturers. Coates was able to get his division to fund Brody at more than $1 million per year, allowing the thin-film group to set up a prototyping facility. But this reprieve was only temporary. Coates left, and although his successor continued to support Brody, the electron tube division began to lose money and was eventually shut down.

By the mid-1970s, the technology had reached a crossroads. Besides liquidating its television division, Westinghouse also eliminated one of the semiconductor divisions that had supported Brody's work early on. This left no logical source of support within the company for Brody's activities. For Westinghouse, the choice was obvious: either invest in a pilot manufacturing facility, so that active-matrix displays could begin generating some revenue, or abandon the effort. In 1979, a committee of Westinghouse executives decided to kill the project.

Why would Westinghouse abandon such a promising new field after pumping millions into basic research and product development? In the words of Coates: "Every aspiration we had, every milestone we set, we missed. We missed timetables, and we missed cost."

In hindsight, Westinghouse could have teamed Brody's innovative group with others who had the managerial and manufacturing skills and experience to turn his ideas into products. This was never even con-

sidered. "At Westinghouse, we really didn't think like that," says an executive who was on the committee that canceled the project. "This was a management failure."

Fits and Start-Ups

Westinghouse's cancellation of the active-matrix-display project ignited Brody's entrepreneurial spirit. In 1979, he left the company and quickly moved to start his own firm to commercialize the technology. Over the next two years, he presented his ideas to more than 40 venture capitalists and electronics companies. Understandably, most wanted to know why Westinghouse had given up on the technology if it was so good. Some also feared competing against traditional picture tube or display technology and against established industrial giants.

One of the first firms Brody approached after splitting with Westinghouse was 3M, mainly because of its reputation for internal entrepreneurship and its record for marketing innovative products. 3M scientists liked the active matrix technology. But even though six of the company's operating divisions expressed interest in the project, none would commit to sponsoring it. Finally, after more than nine months, 3M reported that it was not interested.

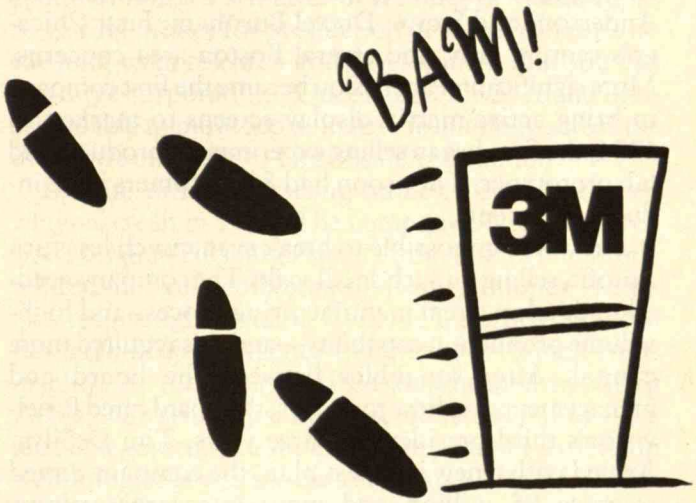
Brody then got the attention of Wall Street venture capitalist Bruce K. Anderson of the venture capital fund of Welsh, Carson, Anderson and Stowe. Anderson suggested that one of his major limited partners might be willing to fund the outfit. That limited partner turned out to be 3M. Even after being told about the previous turndown, Anderson still decided to proceed.

In the brief interim since rejecting Brody's earlier proposal, 3M had restructured. A new vice-president now headed technology development, and the venture capital firm's proposal became his first opportunity to launch a visible new project. As a major producer of overhead projectors, 3M wanted to use active-matrix technology to make LCD overhead projector screens. The board of directors took only three weeks to approve an investment of $1.5 million.

In November 1980, the new company, called Panelvision, was launched. Panelvision bought equipment from Westinghouse's old thin-film transistor labs. By the summer of 1981, the firm had rented a building in a Pittsburgh suburb near the Westinghouse R&D center, and begun developing a process for manufacturing active-matrix display products. Seemingly on the verge of pilot production, the company got an additional infusion of venture capital, bringing total investment to almost $4 million. The venture capitalists, arguing that good management was more important than technology, brought in three new managers to help run the company Brody had founded.

Upon joining the company, two of the three new managers tried to stage a revolution to unseat Brody, urging the board to turn leadership of the company over to them. Their efforts were unsuccessful. The board fired the insurgents—but it also demoted Brody, whom they had concluded was not a good enough manager to safeguard their investment. In an effort to stabilize the company, the board promoted another of the recent hires, marketing vice-president Tom Maloney, to chief operating officer. Maloney had led an engineering group at Burroughs that had successfully commercialized early gas plasma displays. Maloney was close to Brody and was able to work well with him, even in such stressful circumstances.

Panelvision's location may have been a disadvantage. In the high-tech havens of Silicon Valley and Route 128,



venture capitalists are accustomed to dealing with managerially naive scientists and engineers, and they treat palace revolutions as a fact of life. Moreover, they are close enough to the company to step in and take over in a crisis. And they can draw on a large pool of seasoned managers they have worked with before. In Pittsburgh, there was no outsider who could be rushed in to cope with Brody's foibles.

In the process of taking the helm, Maloney realized that Panelvision faced a more serious problem than the ill-fated coup. Its manufacturing process was not working as planned. The group began working with a sophisticated machine developed jointly by them and Westinghouse to produce thin-film circuits. The machine used a series of "shadow masks" that would deposit the various materials in a pattern directly on the substrate, eliminating the need for the multiple photolithographic steps used in conventional semiconductor technology.

But the displays the company was developing pushed the new mask technology beyond the state of the art. The mask machine had previously been used to produce circuit patterns with a resolution of 30 lines per inch; Brody was trying to push it to 50 or more. It became apparent that the equipment could not produce what Panelvision needed, and that a radical process change was required. The shadow mask problem forced the company back into a development mode, delaying the project by two years.

Again, Panelvision's isolated location in Pittsburgh worked against it. Its suppliers were all far away, in Silicon Valley, Route 128, and even Europe. This made interaction in designing and using equipment difficult.

Even so, Maloney was able to turn things around. Under his leadership, the company became reasonbly successful. Between 1979 and 1984, it raised roughly $13 million in six or seven rounds of financing from heavyweight venture capitalists such as Welsh, Carson, Anderson, and Stowe; Drexel Burnham; First Chicago's venture arm; and several Boston-area concerns. More significant, Panelvision became the first company to bring active-matrix display screens to market. In 1984, the firm began selling experimental products and lab prototypes. They soon had 80 customers in 12 industry segments.

But it was impossible to break even, much less turn a profit, selling on such small scale. The company needed to develop a real manufacturing process and high-volume production capability—and this required more capital. After squabbles between the board and management over how to do this, the board hired Panelvision's third president in three years, Tim DeSilva. Armed with a new business plan, the company aimed to raise $5 million and move into larger-volume production.

By this time the Japanese had entered the picture. Seiko introduced a color pocket television in the United States, infringing on the original Westinghouse patents for active-matrix displays, to which Panelvision held exclusive rights. The International Trade Commission encouraged Panelvision to bring suit. The company started this process in motion, alerting Seiko of a potential lawsuit.

Japan's entry sounded the death knell for Panelvision. Investors had already been hesitant about moving from R&D into volume production. Now they thought it utterly foolish to try to compete with the Japanese on their strong suit of manufacturing efficiency. The board of directors decided to recoup its investment by putting the firm up for sale. A team from 3M evaluated the firm and recommended taking it over, but top management declined. In 1985, Panelvision was sold to Litton Industries, which wanted to use the active-matrix technology in aircraft cockpit displays.

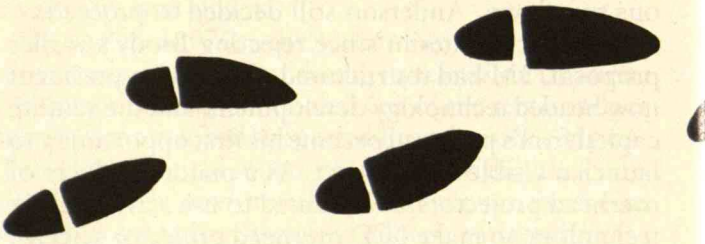
Brody left the company, now called Litton-Panelvision. Maloney stayed on for a time—serving as director of marketing—as did a number of other original Panelvision employees. Litton-Panelvision began to produce display products for its own defense avionics systems but never ventured into the commercial markets. And while Litton made some significant improvements, it was not in the business of advancing the technology. In April 1989, the parent company moved Litton-Panelvision to its main corporate facility in Toronto, where it continues to manufacture cockpit displays.

Thus, after 15 years of fighting corporate battles and braving the entrepreneurial wilderness, Brody seemed to have failed. But convinced of the value of his idea, he decided to try again.

The Second Time Around

In the mid-1980s, the time for Brody's active-matrix displays seemed to have come. Portable computers were becoming popular. Tiny, hand-held TV sets were appearing on the market. After a brief hiatus following the sale to Litton, Brody resumed his crusade. This time, it was the threat of Japanese competition that would prove his major obstacle.

Brody formed a consulting firm, Active Matrix Associates. In late 1985, he tried to get backing for a new start-up. He intended to pick up where Panelvision left off, especially since Litton had confined itself to cockpit displays. But U.S. investors and venture capitalists were put off by Panelvision's inability to come up with a commercial product despite $13 million in investment.



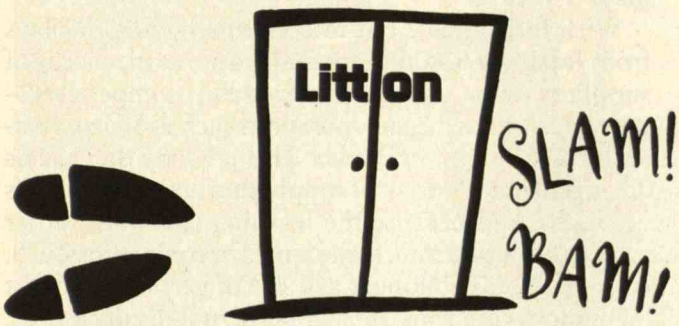
Several major U.S. computer makers were excited by the possibilities offered by flat-panel displays. Apple, IBM, DEC, and Compaq each indicated that they would place big orders, but shrank from becoming involved in the extremely expensive undertaking of building a factory that could produce large volumes of flat-panel displays. They believed it was not the job of computer firms to create their own supplier base, especially since they could buy flat-panel displays from the Japanese.

WITH NO U.S. SOURCE OF FLAT-PANEL DISPLAYS, U.S. COMPUTER MAKERS ARE AT THE MERCY OF SUPPLIERS WHO ARE ALSO THEIR MAIN COMPETITORS.

The most receptive company was Apple, which was planning its Macintosh portable. Enthusiastic about active-matrix displays, Apple told Brody to bring back a proposal for a factory capable of producing 50,000 units a month. But Apple balked at the price tag. The company ultimately decided to buy screens for its portable Mac from a Japanese supplier.

Brody decided to rethink his strategy. The Japanese had been concentrating on small displays (10 to 14 inches across), for laptop computers. Brody decided to develop larger (20- to 40-inch) displays for use in military command-and-control systems and in corporate teleconferencing. Brody saw large displays as the key to the next big frontier—high-definition television. The idea was to create a large screen out of smaller active-matrix "tiles."

In 1987, Brody brought his new business plan to a Boston investment group whose advisory board was chaired by Jerome Wiesner, former science adviser to Presidents Kennedy and Johnson and past president of MIT. Wiesner, a strong believer in the need to strengthen and rebuild U.S. high-technology industry, was excited by the project. He touted its promise and importance, insisted that the investment group participate in the project, and said he would be willing to commit personal funds. The venture capitalists saw Brody's idea as a long shot and declined to invest, but Wiesner made good on his promise. He and close friend Richard Leghorn (the founder of Itek and a cable television entrepreneur) each committed $125,000 of their own money. The new company, called Magnascreen, attracted significant funding from individual investors close to Wiesner and Leghorn—including John Sculley of Apple and a former chairman of Xerox—and from VenWest, the venture capital arm of Westinghouse. All told, the company raised $2.3 million in startup capital. Leghorn alone eventually put up more than $1 million.



Even with such an impressive list of independent investors, Magnascreen was able to garner support from only one traditional venture capital fund. Venture capitalists in New York, Boston, and Silicon Valley turned Brody down. Even the Pittsburgh CEO Venture Fund—where William Coates, Brody's old champion, was now a limited partner—declined to invest.

Venture capitalists were understandably fearful of the entry of the Japanese, who had announced plans to develop a 40-inch active-matrix display by 1995. Even though the Japanese had no products and were forecasting an eight-year time horizon (compared with Magnascreen's proposal for a prototype in two to four years), the looming threat was enough to deter the venture capitalists. Compounding this was the proliferation of Japanese active-matrix products in small consumer electronics, leading some to believe that they, not the Americans, had invented this technology.

Perhaps most troublesome of all, the task of developing large-screen flat-panel technology was simply too big for venture capital. According to Coates: "There aren't many venture capitalists who can shovel in money like that. With venture capital, you usually have a product, and it's a matter of refining or tweaking it, or getting money for production or sales. You can't do the long-term research and development that you can in a large corporation." Once again, Brody found himself unable to move active-matrix technology across the divide from R&D to large-scale production.

Despite difficulty raising money, Brody launched Magnascreen in 1988. The company bought Panelvision's original Pittsburgh facility from Litton, and Brody rehired his old collaborator Tom Maloney. Magnascreen sought funding from the Defense Advanced Research Projects Agency to develop a 45-inch color display. At the time, DARPA was headed by Craig Fields, who strongly supported industrial policy—the idea that government should channel money to develop technologies key to the nation's competitiveness. Brody, naturally, became an ardent proponent of industrial policy, lobbying in Washington and writing letters to the popular press. Although Fields's outspokenness on industrial policy got him fired by the Bush administration, Brody's efforts paid off for Magnascreen. DARPA awarded the company a $7.8 million contract, of which it has so far provided $2 million.

In 1990, Brody once again found himself at odds with his board and his investors. The Magnascreen board wanted a hands-on chief executive who would focus all his attention on the company. Another major conflict centered on Brody's reluctance to accept Japanese investment.

Brody resigned as CEO, and was replaced by Leghorn, the biggest investor in the company. Maloney, who served as vice-president and general manager, assumed responsibility for day-to-day operations. The Magnascreen board and management are now developing a proposal to raise another $3.5 million. They are

THE STORY OF ACTIVE-MATRIX TECHNOLOGY BRINGS US FACE TO FACE WITH U.S. INDUSTRY'S WEAKNESS IN SCALING UP A NEW TECHNOLOGY FOR HIGH-VOLUME PRODUCTION.

working on a new strategy for manufacturing large flat-panel displays for both military and commercial uses. The indefatigable Brody is trying to form a new company to produce small- and medium-sized active-matrix displays in Europe.

The Bigger Picture

Unfortunately, the experience of Magnascreen, Panelvision, and Westinghouse is not unique. Like Westinghouse, other big companies—RCA, GE, Burroughs, IBM, Raytheon, Zenith, Hughes, Texas Instruments, NCR, AT&T, and Exxon—incubated and then abandoned flat-screen display technologies. As with Panelvision and Magnascreen, the remnants of their efforts gave rise to a host of new companies: Plasma Graphics, a spinoff from Burroughs; Electro-Plasma, from Owens-Illinois; and a raft of others, most of which failed. None has developed high-volume production capability.

By failing to capitalize on a big initial advantage in a crucial technology, U.S. corporations have allowed foreign competitors to overtake them. Today, there are no significant active-matrix LCD factories in the United States. In the past few years, four Japanese corporations—Hitachi, Matsushita, Seiko Epson, and Sharp—have invested more than $100 million in such plants in their own country. Hoshiden makes screens for the Macintosh portable. Sharp builds screens for the new Texas Instruments notebook-size computer. IBM recently formed a joint venture with Toshiba, Display Technologies Inc., to produce 10-inch color active-matrix displays for its computers in Japan.

The situation is so serious that U.S. computer makers are siding with the Japanese against the U.S. display makers. Last July, a coalition of seven U.S. flat-screen producers accused 12 Japanese companies of "dumping" flat panel displays in the United States at prices well below those in Japan. But at a preliminary hearing before the International Trade Commission, IBM, Apple, Compaq, and Tandy testified against the U.S. display companies. The computer makers insist that they have no choice but to turn to Japanese vendors because domestic companies are unable to produce large volumes of displays. Even the Semiconductor Industry Association (SIA)—which has aggressively challenged "unfair" Japanese trade, and favors an industrial policy to rebuild U.S. consumer electronics—refused to get involved, perhaps fearing retaliation from U.S. computer firms.

In its initial ruling in February, the Commerce Department found no evidence of dumping by Hoshiden or Matsushita. It imposed small tariffs of 1.46 percent for Toshiba, 4.6 percent for Sharp, and 2.33 percent for the rest. The department was to make a final ruling in July following on-site investigations in Japan.

While significantly higher tariffs are unlikely, even modest increases may force more U.S. manufacturers of laptop computers to move production to Japan, or convince Japanese display makers to move more production to this country. Sharp is already building a $30 million plant in Camas, Wash., where it expects to produce up to half a million portable-computer displays a year.

With little choice but to continue buying displays from Japan, U.S. computer makers are at the mercy of suppliers who are also their main competitors—microelectronics megacorporations such as Sharp, Matsushita, Toshiba, and Seiko. This is a very dangerous arrangement. The risk of supply shortages and cutoffs are high. And because the learning curve and other process advantages are in the hands of competitors, U.S. companies are no longer assured of getting the latest technology and thus are at a perpetual disadvantage.

A number of U.S. firms have begun forming alliances to try to regain some footing in active-matrix displays. Xerox, which developed the technology for use in its printers and scanners, has started a joint venture between its Palo Alto Research Center and Standish Industries of Wisconsin to make active-matrix products, and is looking for other partners. Harris has teamed with Sun Microsystems and the David Sarnoff Research Center, the former RCA research labs where much of

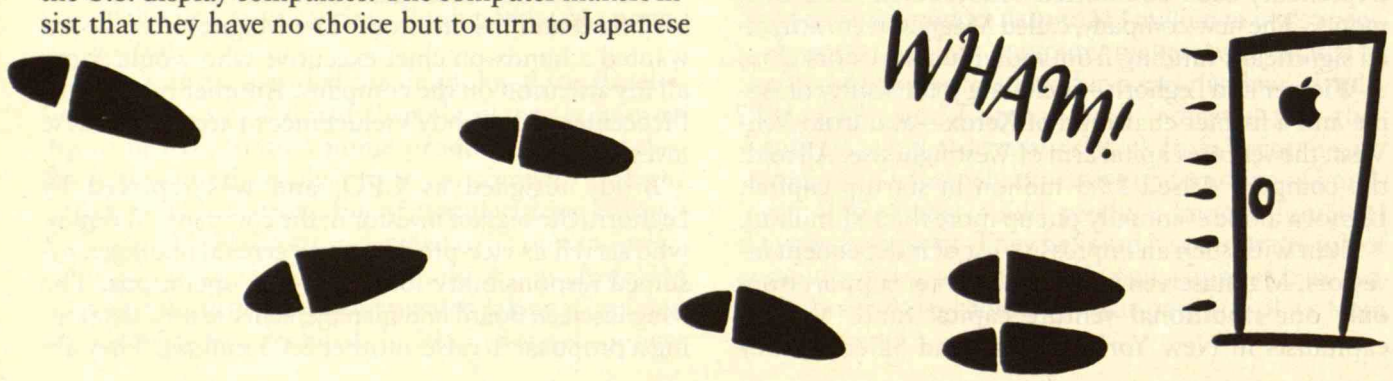


Photo: Reuters/Bettmann

Nuclear-generated electricity saves more oil each day than we used to import from Iraq and Kuwait.

With more than 100 operating nuclear plants in this country, nuclear electricity cuts U.S. oil imports by 740,000 barrels every day. That's more than the oil we imported from Iraq and Kuwait before hostilities broke out last August.

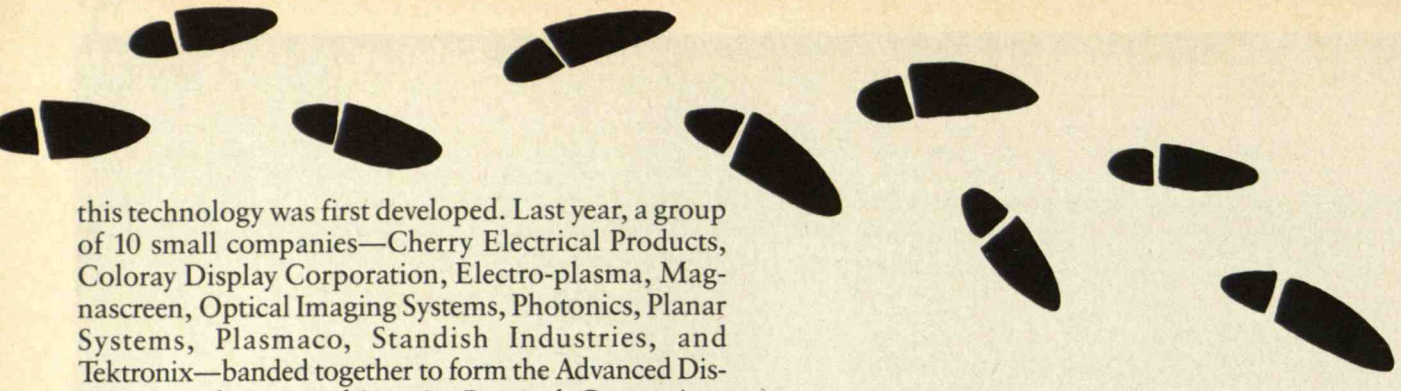
Nuclear energy is a major reason why electric utilities here burn much less oil than they used to. In 1973, 17% of America's electricity came from oil, while only 4% came from nuclear. Today, oil provides 4%; nuclear energy generates over 20%.

But America still imports about half the oil it consumes—the equivalent of four huge supertankers of foreign oil every day.

We need more nuclear plants—to meet America's growing electricity demand, and to bolster our independence from dangerously unstable energy sources.

For more information, write to the U.S. Council for Energy Awareness, P.O. Box 66080, Dept. ST19, Washington, D.C. 20035.

Nuclear energy means more energy independence.



this technology was first developed. Last year, a group of 10 small companies—Cherry Electrical Products, Coloray Display Corporation, Electro-plasma, Magnascreen, Optical Imaging Systems, Photonics, Planar Systems, Plasmaco, Standish Industries, and Tektronix—banded together to form the Advanced Display Manufacturers of America Research Consortium (ADMARC) to develop flat-screen technology. In March, ADMARC received a $1.25 million grant under the National Institute of Standards and Technology's new Advanced Technology program.

While such consortia are a move in the right direction, they are not the answer for the U.S. display industry. Research consortia, by their nature, focus on high-end R&D or advanced development work—so-called generic or precompetitive technology. They have not had great success in manufacturing, where U.S. industry is weakest. Indeed, we may well see a repeat of the computer memory chip story. The Japanese developed high-volume production capability, then captured larger and larger market share that allowed them to drop their prices and corner the world market. When an industrywide consortium, U.S. Memories, was formed to rebuild U.S. capacity, the Japanese dropped their prices again and the consortium crumbled.

Lessons and Solutions

The failure of U.S. industry to commercialize active-matrix technology tells us that we cannot expect entrepreneurship to drive us forward in all areas of high technology. In this case, venture capitalists have proved less—not more—effective than big companies. They are interested in taking technologies that are almost ready for the market and quickly turning them into commercial home runs. If the market for a technology does not open in three to five years, venture capitalists will typically abandon it. If it requires huge capital investment to develop manufacturing capabilities, they generally will stay out altogether.

Venture capital is simply not the mechanism for providing the massive amounts of investment and process development to build state-of-the-art manufacturing. Venture capitalists underwrote this country's semiconductor and computer industries, but they may not again be able to muster the resources to support a high-technology manufacturing industry. The future of venture capital may well be in high-end, high-return markets such as semiconductor design and in non-manufacturing (or nontraditional manufacturing) industries like software—not in industries that require costly manufacturing capability.

The story of active-matrix technology also brings us face to face with U.S. industry's systemic weakness in scaling up a new technology for high-volume production, which is where the long-run economic payoff is. Our system is successful at producing revolutionary new technologies, but fails at developing and constantly improving the manufacturing process. Westinghouse, after all, pumped millions of dollars into its active-matrix display effort. But it abandoned the technology when bigger investments—on the order of $100–500 million—were needed for manufacturing. Says former Westinghouse executive Coates: "We consistently underestimated the difficulty with manufacturability and reliability—the things you've got to have to make it work."

Indeed, it may be too late to save the U.S. flat-panel display industry. We are now so far behind that it may be necessary to form joint ventures with Japanese companies. This should not be too difficult, because Japanese producers want to protect their access to the U.S. computer market and often see such joint ventures as being to their advantage.

How can industry assure that such pivotal inventions will not slip away again? The key is investment in manufacturing. Both Westinghouse and the venture capitalists happily funded Brody as long as he continued R&D. The money dried up at the critical moment when he needed to develop the manufacturing process required for commercial production.

U.S. investments in manufacturing must be coupled with deep organizational and management changes. The (mainly Japanese) companies that have succeeded in active-matrix technology have applied a basic formula: continuous process improvements on the factory floor. In these companies, R&D scientists and engineers work alongside factory workers to make sure the manufacturing process works. The factory is a center for innovation, change, and constant refinement. Such perseverance has, more than any other single factor, spelled success for the Japanese in active-matrix technology. This is where we failed and continue to fail.

This kind of industrial transformation must become a national cause. In the 1930s, when the U.S. economy broke down, American business, labor, and government pulled together to do what was needed to rebuild our economic and industrial might. Somehow we must recapture that kind of energy today. ■

Building a Peacetime Economy

By John E. Ullmann

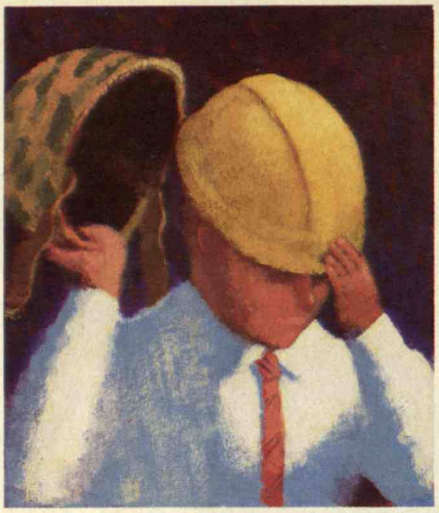
MILITARIZATION of the economy during the Cold War preempted capital and technical resources and landed the United States in industrial decline. There can be little argument over the scale of this phenomenon. From World War II to 1988, the United States spent $9.6 trillion on the military in 1982 dollars—about $1.5 trillion dollars more than the estimated value of all the country's tangible assets except for the land itself. At present, the stock of military "machinery"—weapons—is valued at two-fifths as much as all industrial equipment, and over a third of U.S. engineers and scientists work for the military.

When capital and technical resources pour into the military sector, where market criteria for cost-effectiveness are largely ignored, manufacturers lose the incentive to create and use superior research and more efficient production methods. Major U.S. firms in industries such as electronics, automobiles, and machinery of all kinds, notably machine tools, have become virtual agencies for imports, have gone to foreign sources for the more complex components, or have simply given up. The United States is running a deficit even in high-tech trade, which was supposed to benefit from military-sponsored research.

ILLUSTRATIONS: KEVIN HAWKES

A NATIONAL PROGRAM TO CONVERT MILITARY ENTERPRISES TO CIVILIAN PRODUCTION IS CRUCIAL TO OUR INDUSTRIAL FUTURE.

Military spending has also hobbled civilian public investment. Such investment averaged 1.5 percent of the gross national product from 1953 to 1969 but fell to 0.4 percent from 1970 to 1986. Almost every day brings new evidence of the results. The deterioration of our infrastructure has reached the point where 50 percent of the bridges in New York State and 75 percent of those in New York City reportedly can no longer carry their intended loads. As Bob Hope said when several water mains burst just before the 1989 municipal elections, "New York doesn't need a mayor, it needs a plumber." From California to Florida, the viability of water supplies is threatened. Because spending on infrastructure complements private investment and helps improve productivity, the shortfall of U.S. public investment can even be blamed for much of the stagnation in U.S. productivity, a potent element of industrial decline.



INVESTING IN INFRASTUCTURE AND OTHER CIVILIAN NEEDS RATHER THAN DEFENSE COULD BOOST STAGNANT U.S. PRODUCTIVITY.

The course of U.S. industrial development has left the nation midway between two extremes. Not having burdened themselves with excessive military spending, the Japanese have come to dominate consumer products and the Germans capital goods. At the opposite pole, the whole Soviet industrial sector is run by the kinds of central controls and wasteful production systems typical of defense establishments. The results have been the wrong goods, poor goods, and sometimes no goods at all, as well as environmental abuse. It is obvious in which direction the United States must now head.

Members of Congress and former Defense Department officials have proposed cutbacks in military expenditures on the order of 25 percent in five years or 50 percent by 2000. Although these would begin to shake loose the kind of resources needed, further savings may be possible. Reducing the U.S. presence in Europe is an immediate chance to save tens of billions of dollars, much more than offsetting the costs of deploying forces in situations such as Iraq. Advanced Cold War arms such as B-2 bombers, Star Wars, attack submarines, and the planned F-22 fighter (a $95 billion program) are likely to be cut eventually—if not for excess cost, then for lack of a plausible enemy. Even in the middle of the Iraq war, the government canceled major contracts such as those for two attack submarines, the F-14 fighter, and the A-6 Intruder aircraft, and announced plans to close or scale back large military bases. Tens of thousands of layoffs are already scheduled.

In the difficult economic climate that can be expected in the rest of the decade, the resources to strengthen U.S. industry can come only from the military. Money rescued from defense should be used to rebuild the infrastructure, modernize our ground transportation system, and promote energy R&D. The Iraqi war corroborated the judgment of those who have argued all along, as I have, that Cold War strategy prepared for the wrong battle in the wrong place and that oil imports are the country's main national security problem.

We do not need another Gosplan, but as a nation we can begin charting the scope of conversion and defining markets for alternative civilian products. Shifting government spending from the Pentagon to nonmilitary investment would provide civilian markets for some former defense contractors and facilities. Defense firms could also find private markets—for example, supplying components to commercial aircraft companies or to foreign manufacturers that have set up plants in the United States. The government should provide individuals with retraining programs and financial assistance. And while it would not be feasible to single out particular contractors or bases for special protection, the government can at least offer advice on possibilities for conversion.

Civilian Jobs to Be Done

The scale of conversion now necessary is unprecedented. About 2 million people serve in the U.S. armed forces, 1 million civilians work for the Pentagon, and 4 million people are employed by firms working largely or entirely on military contracts. By comparison, the conversion problem after World War II—even though it involved more people—was simple. In those days the United States had a huge pent-up market for consumer goods backed by huge accumulated savings. Only U.S. industry could supply that market because other major powers had been devastated by the war and U.S. tech-

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nical leadership was paramount. Since the war effort had lasted just four or five years, many plants needed to do no more than return to what they had previously been making.

Today, markets for most products are largely saturated, and consumers and industry have no pent-up savings to spend. (Indeed, the national savings rate is notoriously low.) Many military plants, bases, and other facilities never had any commercial purpose. Employees have never known what it is like to work in the cost-conscious civilian sector. Military specifications often stretch technology to excessive limits, and, contrary to the common view that weapons have to work no matter what, they often have defects and functional failures that would never be accepted in commercial products. More serious still, the "no matter what" concept rarely provides incentives to minimize costs. The first victim of this kind of thinking is the once great American skill in making a technically sophisticated product commercially successful.

Conversion requires first that military firms find civilian markets to serve. Some commercial markets already exist, notably in aerospace. Boeing dominates here with a backlog that passed $100 billion in early 1991, as domestic and foreign airlines renew their aging fleets. Several major U.S. airlines are in trouble, but stronger ones like Delta are in the market. Though no longer the only game in town, the United States still is relatively strong in aerospace export markets, one of its few remaining centers of strength. Military firms could become part of Boeing's expanding network of subcontractors.

To succeed, these firms would have to make major changes. Boeing has a reputation for hard bargaining and does not offer "progress payments" (regular payments the Pentagon makes to suppliers while the contract runs). Also, military production is inefficient. Grumman of Long Island, for example, makes about 60 military aircraft a year by what one of its executives calls "handicraft methods." Such labor intensiveness is problematic in commercial aerospace. Yet if military firms like Grumman can become competitive, they could help fill Boeing's backlog of orders. In so doing, they would reduce the long lead times for planes and ensure that Boeing's future sales are not jeopardized.

With similar changes, former military contractors could also sell commercial avionics to foreign manufacturers such as Airbus and provide better air-traffic control systems and detectors for wind shear and clear-air turbulence. The slow pace of renewing such equipment could be greatly speeded up by using savings from military cuts to supplement current taxes on commercial aviation. Wind-shear and turbulence detectors offer a chance for the "spinoff" from military work—in this case on radar—that the defense establishment has so often promised.

Another potential market is foreign-owned plants, which have begun a small renaissance in manufacturing. Virtually all major Japanese firms in automobiles, electronics, and electrical equipment now have substantial U.S. operations, and European interests have bought up many American firms, as Siemens did with Allis-Chalmers. Some of the plants have gone on as before, with welcome infusions of new capital and product development. Others started doing "screwdriver assembly" of largely imported components but have expanded production and developed networks of U.S. subcontractors. In 1990, when Gov. Richard F. Celeste of Ohio

Potholes like this one near the United Nations Building are a common sight in U.S. cities. Our infrastructure has deteriorated to the point where 75 percent of the bridges in New York City reportedly can no longer carry their intended loads.

PHOTO: UPI/BETTMANN

invited small defense contractors to a conference on conversion, the most popular workshops by far were on how to become subcontractors for Siemens and Honda.

If the government reverses past neglect by rebuilding the infrastructure, renovating ground transportation, and improving the energy efficiency of the entire economy, other big civilian markets will open up. Consider first energy. To reduce oil imports and deal with global warming, the government should restore tax incentives for conservation and increase R&D support for conservation and renewable energy. Congress ought to mandate improved fuel efficiency for cars, appliances, and industrial equipment. Such changes would stimulate demand for a range of equipment, from familiar products to those still needing basic R&D.

For instance, the technology is largely in hand for cogeneration, a potentially rich means of conservation that makes electricity from the "waste" heat produced by industrial processes or large heating systems. Some products, like heat exchangers, pumps, fans, turbines, and generators, could well become major appliances for improving home energy efficiency rather than specialized industrial goods. A radical German concept is to replace oil burners with diesel or diesel/natural-gas engines that would drive a small generator for lighting and a heat pump to provide heating and air conditioning. Waste heat would provide hot water, and surplus electricity would feed into the public supply.

In the automotive field, the government should stimulate the development of efficient internal combustion engines and of electric propulsion through tighter federal mileage standards and adequate R&D support. While battery-driven vehicles still need substantial R&D, the old concept of using a small engine that charges batteries to power an electric drive seems more quickly realizable. Such engines could run constantly at optimal speed and power, with the electric drive handling acceleration. Federal R&D funding should provide much more—and more sustained—encouragement for new sources of electricity like photovoltaic cells, windmills, biomass, and geothermal energy, as well as for sea water desalination, an urgent need that is potentially related. At least some of these concepts should pan out reasonably quickly.

Electrifying major rail systems is another good way to save energy and create big new markets. In this undertaking, other industrialized nations are far ahead of the United States. Except for a couple of small gaps, for instance, one can travel under electric power from Spain to the Pacific shore of the Soviet Union and from Norway to Sicily. While there are many high speed rail connections in Western Europe and Japan, plans put forth here, as they have been in Florida, Pennsylvania, Ohio, the Northeast Corridor, and California, fade away without action. Nowhere else is it considered unseemly for governments to finance major public works. The U.S. government should overcome its reluctance to do likewise.

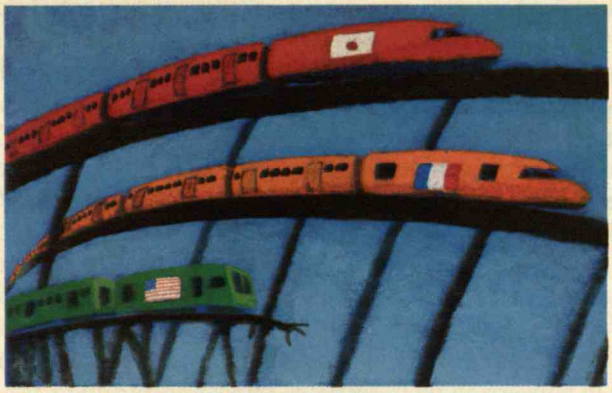
In one realistic project for the United States, the rail industry could, with some public funding, commit about $100 billion over 10 years to electrify 60,000 miles of the basic rail network. Clearly, the potent lobby of truckers, oil companies, and roadside services such as truck stops would oppose this scheme. But it would be invaluable for energy conservation, since containerized rail freight uses only a quarter the energy of trucks. Such a rail system would also reduce petroleum imports because the electric power could come from several sources besides oil, which diesel locomotives must use.

U.S. local transit systems need just as much attention. New York City alone is home to a host of failed

A former arms factory in Donetsk in the Ukraine now builds toy cars. Soviet conversion efforts offer a poor model for the United States because they often retain military-like bureaucracies and fail to ensure cost-conscious production.

PHOTO: TASS FROM SOVFOTO

projects, including the laboriously built but now half empty 64th Street tunnel under the East River and the unfinished Second Avenue subway, not to mention abortive plans for airport access by subway or other rail and for an East Side terminal for the Long Island Railroad. These examples contrast painfully with a new line of the Moscow Metro finished on schedule in 1990, the cross-city links of Paris and London, and dozens of other burgeoning transit projects around the world. With its current fiscal troubles, New York City by itself can do little. But adopting the same funding formula used for highways, whereby the federal government pays 90 percent and the locality 10 percent, would clearly help.



While there are many high-speed rail connections in Europe and Japan, similar plans here fade away without action.

Despite great opportunities, conversion faces major uncertainties. The size of many of these potential markets depends on the amount of money freed from defense that could be spent on the civilian sector, and it is difficult to say what military contractors could succeed in what businesses. Producing goods that are significantly better than existing ones would be a tall order. Converted enterprises would face competition from imports, the U.S. operations of foreign producers, and American firms that still develop civilian products. The management of each facility serving the military would face a choice whether to compete in new markets, downsize (as the economist Murray Weidenbaum advocates), or close altogether. The outcome would depend on managers' ability to respond to the new conditions.

Who Must Convert . . .

Five categories of military installations or suppliers will require conversion. First, firms that sell only some of their usual products—such as food, light bulbs, towels, and other common items—to the services will have the fewest problems. Their products will still be needed in the commercial market.

Next in order of difficulty are contractors with up to 500 employees doing specialized work—say, producing electronic and electromechanical components—that sell much or all of their products to the military. The number of such firms shrank from about 138,000 in 1982 to 40,000 in 1987, mainly because, as the Reagan arms buildup peaked, prime contractors produced more components themselves. Some 78,000 of these firms adapted their skills to producing parts for commercial equipment such as robots or computer subsystems. For example, Frisby Airborne Instruments in Freeport, New York, managed to apply its expertise in hydraulic systems for makers of material-handling equipment and commercial aircraft. So far, such firms are the biggest U.S. example of successful conversion. Nevertheless, the transition has required major operating changes and, in some cases, layoffs. And about 20,000 small former military contractors could not make the transition and went out of business between 1982 and 1987.

A third and more problematic group consists of large companies such as General Electric, General Motors, and IBM that have both military and nonmilitary divisions. Although one might think that they would deal with conversion through internal transfers of work, top managers are often reluctant to make such shifts because the military divisions use specialized equipment and operate inefficiently. Moreover, nonmilitary divisions of such firms may themselves have been cut back because of limited markets, unsatisfactory products, or corporate shifts away from manufacturing, in which case little is left to share. Headquarters may simply close the military plants. At Unisys in Minneapolis, for example, loss of defense work could mean closing the plant because the company has had trouble hanging on to a sufficient market share in computers and has had to shrink overall.

The defense divisions of these companies would face challenges much like those of the fourth group—large military contractors such as Grumman, General Dynamics, and Lockheed that make little else besides weapons, naval vessels, and military aircraft. To survive in the commercial world, they would need major new products, extensive retraining of personnel, new or substantially rearranged production facilities, and, above all, cost-efficient management. Clearly, they could find a niche in some of the large markets described earlier, provided their new products are original, high in quality, and competitively priced. But there could well be major casualties among them.

The fifth category, likely to be even more problematic, is military bases and their personnel. Base closings often cause serious harm to local economies, especial-

ly when the bases are the main employers in remote areas. Although bases with facilities like weapons ranges or munitions factories are hard to convert, some—in Maine and upstate New York, for example—have successfully turned themselves into industrial parks. Of 87 installations now scheduled to close, several, including Pease Air Force Base in New Hampshire, are making similar efforts.

. . . And How

Managers and employees at particular plants must wrestle with three major issues in converting their operations: redesigning the facilities, retraining the staffs, and surviving economically while they make the necessary changes.

Basic decisions about products would dictate the redesign of facilities and the extent to which existing machinery and buildings could be used. While a careful inventory of machinery and buildings is necessary to decide whether they are suited to civilian manufacturing, the question of layout is also crucial. Unfortunately, the norm in military production is the job shop, in which machines are grouped by kind and products are shuttled back and forth between them. This setup allows for versatility, but it is expensive and it means that machines often sit idle. By contrast, a mass production layout passes the product through a single sequence of operations. Though less versatile, this arrangement incurs lower production costs when quantities are large. Some alternative civilian products would be made in the small quantities feasible in a job shop, but others would be needed on a larger scale, which would make major reequipping necessary.

Retraining personnel and easing their transition is in many ways the central problem of conversion. The approach will differ greatly according to an individual's skill and position. Military industry's relatively few unskilled workers—people who, for example, merely mind machines or help move material around the plant—might find employment in construction if there is significant infrastructure renewal. Or they could work on assembly lines if energy-related or other suitable industries arise.

Skilled shop workers may be readily transferable, provided viable new products have arisen. These workers are often versatile and familiar with a variety of machines. For them, the difference between military and civilian production lies mainly in the greater cost-consciousness of the commercial atmosphere. To put it less delicately, they might have to work harder.

Clerical workers are also versatile, but fewer of them might be needed. Unlike civilian employers, defense contractors often have equal numbers of production workers, engineers, and administrative staff, including clerical personnel. Many clerical workers may be highly specialized in the bureaucratic maze of military work, and few commercial activities could sustain so large a proportion of administrative overhead. Still, good clerical help, able to handle computers, is in many places scarce enough that these workers should be able to find alternatives.

Engineers might also have trouble finding new jobs. Their military work is for the most part highly specialized, not only in its technical content but in the combination of secrecy and red tape for which the field is notorious. Because cost in military work is secondary, many engineers in both production and research do not understand cost-efficiency. They would have to be extensively retrained for a commercial environment.

Yet the task may turn out to be easier than expected. The research lag in the United States is so widespread that retrained engineers and scientists could be in great demand in commercial industry. Since they are used to learning throughout their working lives, some of the retraining would merely replace what would be needed anyway in their present work. Moreover, military engineers and scientists often have considerable outside professional talents and interests. Some have good ideas for commercial applications of their work—but little faith in the ability of their managements to carry such possibilities to commercial success.

As this lack of confidence suggests, managers may have the hardest time finding civilian jobs. That prospect has in turn made them a potent source of opposition to conversion. Much of a manager's performance depends on personal relationships and contacts rather than on any technical or other professional knowledge. Such networks are not easy to create in a new field and certainly not on short notice. But managers, too, may have some options. Most have other professional training in engineering, science, business, or law. They will surely regard accepting jobs along these former lines more favorably than being thrown on the scrap heap.

How long would it take to convert a military plant or facility into a commercial one? About the only detailed analysis of the necessary planning is to be found in a 1964 study I directed. The study sets forth all likely tasks for a given facility, some to be done in sequence, others overlapping. The minimum time for completing them turns out to be roughly two years. This assumes that the firm has already decided generally what product it will make—a potentially complex and time-consuming problem in its own right. But the analysis also assumes that the company must do substantial research on the product, a task that may not always be necessary.

Because of the time it takes to convert production, contingency plans for how to do so should have been made long ago and constantly updated. In their absence, the transition period would have to be financed by the Pentagon's contract cancellation allowances, which tend to be generous to a fault. Something like

unemployment insurance for business would hardly be feasible politically.

A Need for Action

Conversion must not be mere work relief for a diminished military establishment. It must be a concerted effort to redirect the nation's energies toward restoring its industrial health. This means diverting substantial military funds. They would be used to undertake needed public projects and thereby establish civilian markets, to help support R&D—especially in energy-related areas—and to provide people with financial help during conversion or if the facility they work for is closed. Governments, including states and localities, may also offer advice to managements and individuals by making use of public and private educational institutions, as the Enterprise Ohio program has done. A good conversion program would in turn help avoid political pressures to "save jobs" in the military sector by preserving contracts and facilities that not even the Pentagon wants any more.

SOME MILITARY FIRMS MIGHT BECOME SUBCONTRACTORS TO CIVILIAN AIRCRAFT PRODUCERS.

Current government policy does not effectively address the need for short-term help or establish conversion planning. The Office of Economic Adjustment (OEA) in the Department of Defense has a limited mandate to provide "adjustment" assistance. For example, it can advise communities in applying for development assistance from an ever more penurious Economic Development Administration, originally established to help the nation's poorest areas over their worst times. The OEA also gives "outplacement assistance" to individuals, helping them with résumés and counseling, but not providing income support or aiding in the job search.

As for developing nonmilitary products, the Defense Advanced Research Projects Agency (DARPA) tried to encourage some research that had civilian applications, but it was quickly stopped in the spring of 1990 and its director was forced out. There is in any case a serious question whether Pentagon agencies are the right ones to do industrial planning. The Technology Administration in the Department of Commerce thinks of itself as a potential civilian DARPA. It must tread carefully, however, to avoid seeming to promote industrial policy, and its budget is less than $10 million. Congressional attempts in 1990 to increase its support failed to yield results.

Many legislative proposals to facilitate conversion have been made since Sen. George McGovern (D-S.Dak.) introduced the first one in 1963. All would provide those displaced with some help in the form of retraining assistance and income support. They differ in their requirements for alternative-use planning. By early 1990 there were seven such proposals before Congress. Although some action seemed possible, the Iraqi war derailed it. Little has happened so far in this session of Congress.

The most comprehensive bill was that of Rep. Ted Weiss (D.-N.Y.), which, in addition to providing wide-ranging income support, required that alternative-use committees of labor and management at military-related facilities develop conversion plans. That turned out to be the bill's most controversial feature. Critics claimed that managements of most military firms have little inclination or competence to undertake such a task. If this appraisal is correct, then the managements' only option may be simply to close down and walk away. Unfortunately, forcing people to be sensible about their futures is indeed difficult. Perhaps not much can be done beyond providing markets and opportunities and hoping that entrepreneurs will quickly materialize.

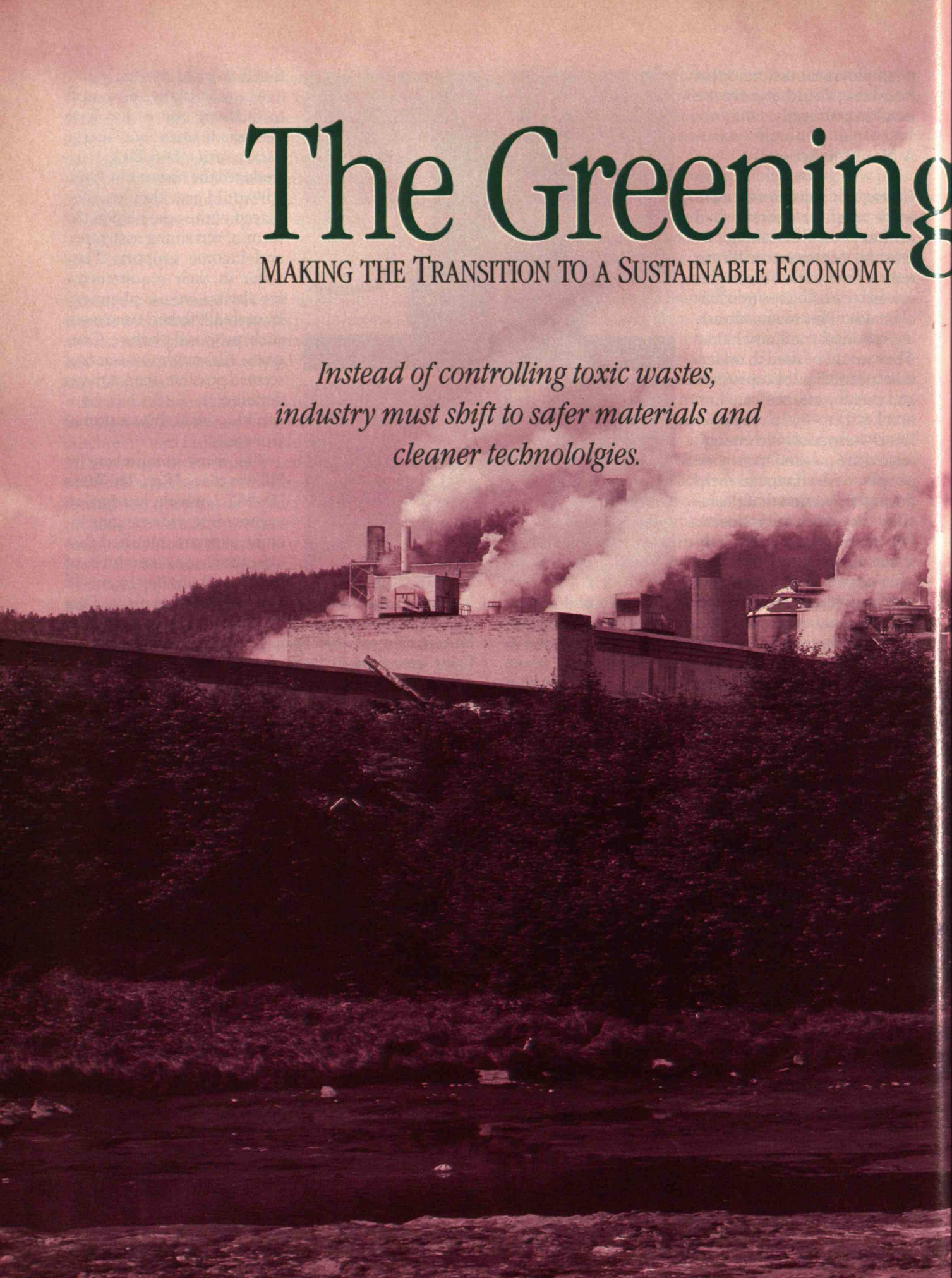
The most serious obstacle to conversion legislation is that all administrations have opposed it. They have discouraged contractors from alternative-use planning and insisted that anything other than leaving matters to "the market" constitutes "industrial policy," which in turn means central direction. Nothing could be more absurd. However disastrous Soviet-style central direction may be, all industrial countries—from dictatorships like South Korea to liberal democracies like Sweden—have industrial policies, meaning sustained government concern and assistance for shaping their industrial futures. The United States has also pursued an industrial policy of sorts: excessive concentration of resources in the military sector.

That must change. What is at stake in conversion is nothing less than the nation's economic future. If there is one task that should now command widespread popular and political support, this is surely it. Failure to take action now would be one of the most portentous blunders in U.S. history. ■

The Greening

Making the Transition to a Sustainable Economy

Instead of controlling toxic wastes, industry must shift to safer materials and cleaner technololgies.



# of Industry

By Ken Geiser

Once belching smoke and foamy rivers visibly symbolized industrial pollution. Today, as concern moves to the global accumulation of invisible and persistent toxic compounds, the ecological impacts of chemical contaminants are

The move toward sustainable industry stems from the shortcomings of 25 years of pollution control regulations.

inspiring a reassessment of the basic elements of industrial production. Whether the issue is hazardous waste, acid rain, the depletion of the ozone layer, the greenhouse effect, or the scarcity of fresh air and water, the root of concern is the same: the inappropriate use of materials and technologies.

The result is an international consensus around the need to reconsider conventional approaches to environmental regulation. In this country, state governments are taking the initiative with "toxics use reduction" laws that focus on cutting toxic material inputs rather than controlling chemical wastes. The U.S. Environmental Protection Agency (EPA) has endorsed "pollution prevention" strategies over conventional pollution control. And in Europe, the same philosophy underlies the "precautionary" approach and the notion of "clean technology."

By whatever name, these policies suggest a new paradigm in environmental policy, one that entails transforming the materials and technologies of production. The goal of this paradigm is to devise a system of sustainable industrial practices that can be implemented without posing undue environmental risks now or in the coming decades.

The concept of sustainability first emerged regarding agricultural policy. Sustainable farming aims to lessen the need for chemical pesticides and fertilizers in favor of practices that work with natural ecological cycles to improve the soil and increase the pest resistance of plants. While the shape of sustainable industry is still emerging, several features will be critical:

- ☐ Technologies appropriate to the desired ends.
- ☐ Safe and environmentally compatible materials.
- ☐ Products that meet basic social needs and some individual wants.
- ☐ Low- and no-waste production processes.
- ☐ Safe and skill-enhancing working conditions.
- ☐ Energy efficiency.
- ☐ Resource conservation to meet the needs of future generations.

The transition to sustainable industry will not be easy. Consider the hurdles to lessening society's dependence on chlorine-based hydrocarbons. Each year, the world processes 24 million tons of ethylene dichloride, the chlorinated hydrocarbon produced in the largest volume. Of that, 87 percent is needed for making vinyl chloride, essentially all of which is polymerized into polyvinyl chloride. PVC has replaced wood, cotton, copper, paper, and other materials in products ranging from toys, house siding, and sewer pipes to textiles and food packages.

But PVC manufacturing creates huge volumes of hazardous wastes. What's more, vinyl chloride, a known carcinogen, is directly linked to liver angiosarcoma among workers in plants that make PVC. And lethal smoke emitted when PVC building products burn raises the risks of fatalities from house fires. It was because of such concerns that Sweden, Denmark, and Switzerland took steps in 1990 to ban PVC in some products and applications.

The challenges to moving rapidly to sustainable energy use are similarly daunting. The 1987 Toronto Accord, signed by over 50 nations, calls for cutting carbon-dioxide emissions 20 percent by the year 2005. But carbon-based fuels account for 85 percent of the global energy supply. The world took nearly 50 years to move from wood to coal as its primary energy source and another 50 to move to oil.

The goal of replacing common substances like PVC or oil in our daily lives suggests the scope of the revolution taking place in the thinking about chemical hazards. The new paradigm for environmental protection will extend into decisions about the materials society consumes, the technologies for manufacturing goods, and the responsibilities of government and industry to protect the biosphere. In essence, sustainable industry means converting the material basis of society.

Shifting Assumptions

The move toward sustainable industry stems from the shortcomings and failures of 25 years of pollution control regulations. Conventional environmental protection policy seeks to safeguard the public by setting conditions and limits on the release of contaminants. Except for some exposure prohibitions in occupational health and safety laws, governments have focused on wastes, emissions, and air and water quality while rarely intervening in the decisions of private firms about their selection of materials or technologies. In other words, the regulations observe the traditional boundaries between public and private property, applying only to substances released into the public air and water.

Conventional regulations, such as those developed under the Clean Air and Clean Water acts, are based on the assumption that the environment has an unlimited capacity to assimilate small amounts of contaminants with negligible risk. By establishing emission standards, this approach proposes that the environment dilutes or transforms chemicals so thoroughly that they

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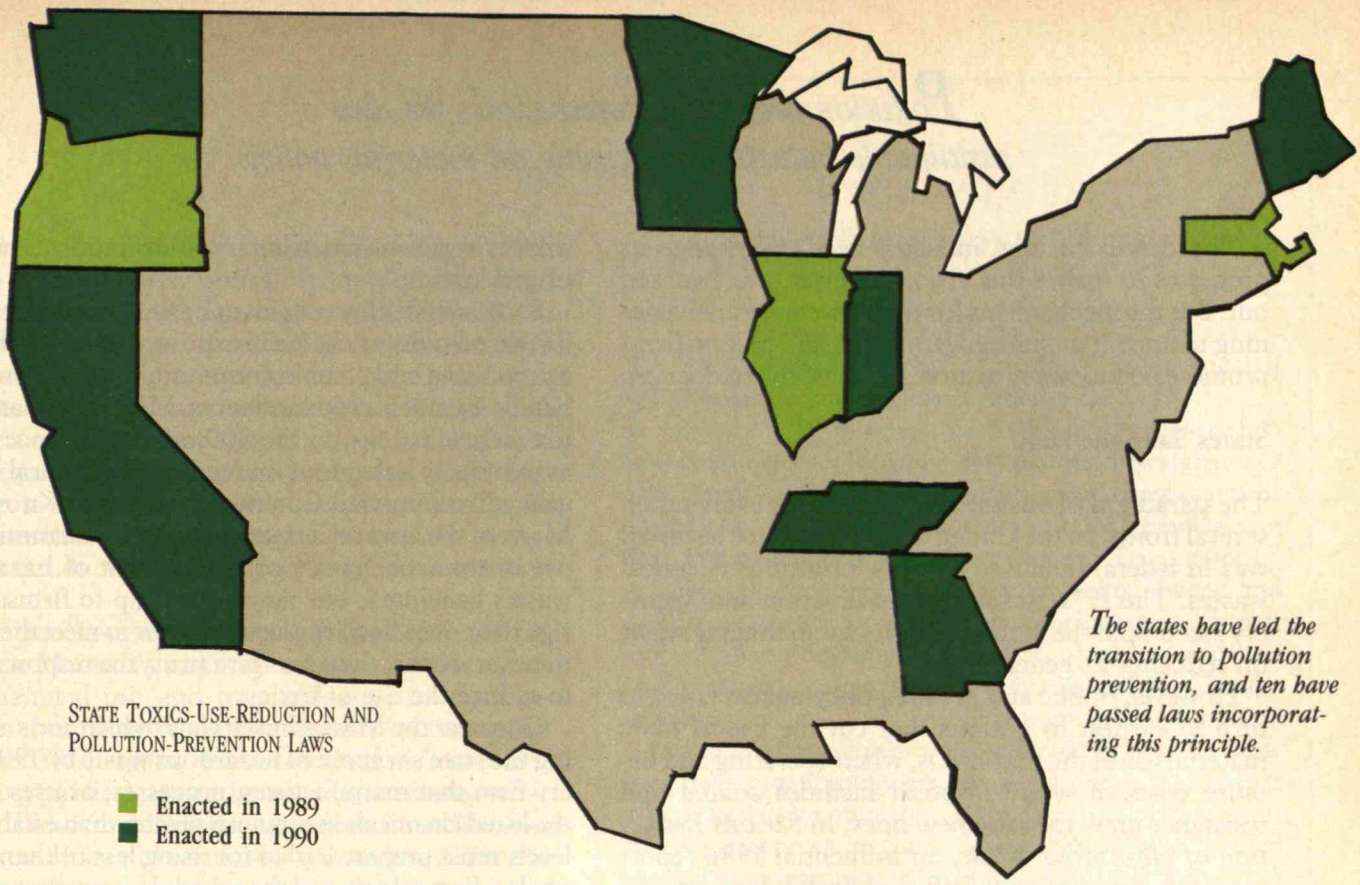
KEN GEISER participated in drafting the Massachusetts Toxics Use Reduction Act and serves as the director of the Toxics Use Reduction Institute at the University of Lowell. In the past year, he has promoted new chemical management policies across the country and in several international forums. He received his master's and doctoral degrees from MIT's Department of Urban Studies and Planning.



The states have led the transition to pollution prevention, and ten have passed laws incorporating this principle.

become mere traces and do little damage, and that contaminants, once diluted or altered by the environment, can't reconcentrate or re-form. The assumption is summarized in the adage "The solution to pollution is dilution."

However, many synthetic materials, especially those based on chlorine or heavy metals, resist degradation. DDT, PCBs, mercury, and cadmium compounds stay toxic for decades. Even when these substances are released within permitted levels, ecological forces slowly move them into the quiet eddies of the environment. The substances collect in the upper atmosphere, the depths of aquifers, and the sediment of lakes and oceans.

These concentrations are all the more worrisome in food chains. Some persistent chemicals easily bond to fats in living organisms. If the organisms are elements of primary food chains, the chemicals can concentrate further as more complex organisms consume them. The most recent National Human Adipose Tissue Survey, conducted in the early 1980s, found over 100 such contaminants in tissue samples taken from Americans regardless of their occupation or where they live.

Additional proof that assimilation-based regulations have failed arises from studying environmental quality data. In 1988, Barry Commoner evaluated 15 years of pollution control regulations in the United States. Reviewing annual EPA air samples and water quality data from nearly 400 sampling stations, he found that environmental quality had improved only slightly and in some cases had worsened. The rate of air quality improvement, which averaged 1.52 percent per year before 1980, dropped to 1.16 percent per year in the 1980s. Despite nearly $100 billion spent to clean up water, quality had deteriorated or remained constant at over four-fifths of the test sites.

Commoner did offer one hopeful finding. Pollution levels had fallen for DDT and PCBs in wildlife, for mercury in the Great Lakes, and for strontium 90 in the food chain, and lead in the air had dropped by as much as 70 percent. All these cases had one thing in common: production or use of the substance was phased out or stopped. Rather than relying on assimilation, Commoner says, "the best way to stop toxic chemicals from entering the environment is not to produce them."

At the same time that such findings have discredited the idea that assimilation is enough, other features of the regulatory approach have also gone through a reassessment. Industry uses well over 65,000 chemicals, with nearly 1,000 new substances added each year. Adequate toxicological data are available on fewer than 1 percent of all industrial chemicals. Federal agencies face the nearly impossible task of setting "acceptable" limits on releases of each substance.

The need to go beyond assimilation and chemical-specific regulations challenges the distinctions both between public and private property and between wastes and materials. Such distinctions are giving way to a view that integrates industrial and environmental needs into a single vision of sustainable industrial development.

MAP BY: CARRI MULLANEY

Pollution prevention foreshadows the idea of sustainable industry by focusing on materials policy.

The details of how industry needs to change its processes to realize this vision have yet to be worked out. But the mechanisms for this movement are beginning to appear as state governments and private firms promote pollution prevention and toxics use reduction.

States Take the Lead

The paradigm of sustainable industry is evolving on several fronts. In the United States, one place it started was in federal policy to address hazardous chemical wastes. The 1976 Resource Conservation and Recovery Act placed the highest priority for managing waste on reducing its generation.

However, public and private policymakers failed to turn in earnest to options that cut the use of toxic materials until the mid-1980s, when operating and liability costs of waste disposal facilities soared and resistance grew to siting new ones. In *Serious Reduction of Hazardous Waste,* an influential 1986 report from the congressional Office of Technology Assessment, Joel Hirschhorn advocated shifting waste management policy from pollution control to pollution prevention. The following year, the EPA established a special Office of Pollution Prevention to guide agency programs toward this goal. In its first three years, the office prepared a policy statement on pollution prevention, organized several conferences, and awarded about $10 million to state technical-assistance programs. But only in the past year has the prevention approach begun to take firm hold within the federal government.

In the absence of a strong commitment in Washington, state governments have led the transition to pollution prevention. By the mid-1980s, North Carolina, Minnesota, New Jersey, and other states had begun offering technical assistance to firms attempting to reduce their waste streams through preventive actions. By the end of the decade, several states had enacted comprehensive laws along these lines. The new laws bypass debates over acceptable levels of toxicity and the risks of specific exposure levels or releases. They rest on a simple argument: the use of every toxic chemical should be reduced or eliminated.

In 1989, Massachusetts and Oregon took the first step, enacting model laws aimed at toxics use reduction. In all, ten states have now passed laws incorporating some features of these programs (*see the map on page 67*), and at least four more are considering them. Six state laws roughly follow the Massachusetts definition of toxics use reduction: "in-plant changes in production, processes, or raw materials that reduce, avoid, or eliminate the use of toxic or hazardous substances or generation of hazardous by-products per unit of production."

Such laws neither require risk assessments nor establish thresholds for chemical exposure. Instead, they set up reporting and planning responsibilities for firms that handle specified toxic substances. Most states base their toxic chemical list on the 300 or so substances cited as extremely hazardous under the 1986 federal Emergency Planning and Community Right to Know Act. Many of the laws set a statewide goal for stemming the use of toxic chemicals or the amount of hazardous wastes generated, but they leave it up to firms to design their own "facility plans" for how to meet the goals. In other words, the plans give firms the responsibility to reduce the use of toxics.

Consider the Massachusetts law, which aims at halving the state's volume of hazardous waste by 1997. Every firm that manufactures, processes, or uses any of the listed chemicals in amounts greater than established levels must prepare a plan for using less of them. The goals a firm selects and the schedule it pursues are determined by those preparing the plans. The act suggests, but does not prescribe, the technical options a firm should consider (*see the box on page 69*). Although the plans are confidential, company managers must release summaries of them along with the goals they have adopted. After 1994, when the plans are due, each firm must report on its yearly progress in meeting its goals.

In the first year of the program, over 600 Massachusetts plants have reported that they are required to prepare plans. Digital Equipment, Monsanto, AT&T, and a few other companies have volunteered to try out the planning process before the required date. The state has set up an Office of Technical Assistance to assist small and medium-sized firms, and has started an intensive combined media inspection program in one region. A Toxics Use Reduction Institute has opened at the University of Lowell to develop professional training programs and study new technologies and safer material substitutes. To aid those who will prepare facility plans, the institute is preparing a training curriculum that should be available this fall.

In contrast to fierce debates over most environmental legislation, the Massachusetts law was not forced upon an unwilling business community. Instead, it was drafted through intense negotiation between industry leaders and environmentalists. The business coalition—the Associated Industries of Massachusetts and small-business trade associations—wanted a narrow bill that linked waste reduction to the siting of a hazardous-waste treatment facility. The environmental coalition—the Massachusetts Public Interest

Research Group and various academics—sought a bill with an array of policy options from requiring firms to report chemical use to giving the state authority to demand the phase-out of certain chemicals. For over four months, the negotiators debated and drafted each line of the bill. The discussions united both sides in support of a proposal that the state legislature passed unanimously. The collaboration has continued through the process of writing regulations and developing the procedures that firms will engage in to consider changing their production technologies and their selection of materials.

Other state laws vary in emphasis, goals, and specificity. The Maine law commits the state to reduce both toxic chemical use and toxic releases. Indiana encourages but doesn't require facility plans. Massachusetts, Washington, Tennessee, Oregon, and Maine firms must publicly report chemical use annually, while those in Illinois and Indiana can report privately. Most states provide small businesses with technical help in preparing plans.

These laws stretch the boundaries of pollution prevention in several significant ways. First, they focus on chemicals in use rather than on wastes. Second, firms must set goals and make plans, not just comply with an emission limit. This emphasizes creativity and innovative technology. Third, the laws encourage continuous improvement, not simply reaching a regulatory threshold.

Prevention and Precaution

These state laws to reduce the use of toxics are often spoken of as pollution prevention, yet most seek to lessen the need even for chemicals that don't affect waste streams or whose risks aren't definitely established. Thus, toxics use reduction foreshadows the idea of sustainable industry by focusing on materials policy as much as on environmental or waste policy. A similar policy shift is occurring abroad as well.

In 1987, the environmental ministers of northern Europe, meeting to discuss the deterioration of the North Sea, endorsed a far-reaching "precautionary principle." They backed an approach that would "require action to control inputs of [toxic] substances even before the causal link has been established by absolutely clear scientific evidence." The North Sea ministers asked for action "when there is reason to assume that certain damage or harmful effects on the living resources of the sea are likely to be caused by such substances."

Like toxics use reduction, the precautionary principle contrasts with policies that simply seek to keep risks to a supposedly manageable level. "In practice, [precau-

Techniques for Reducing Toxics Use

FOLLOWING the lead of the Office of Technology Assessment's 1986 report, *Serious Reduction of Hazardous Waste,* 10 states have passed laws that encourage firms to prevent pollution and to reduce their dependence on toxic materials. Companies can comply through various technological means, including:

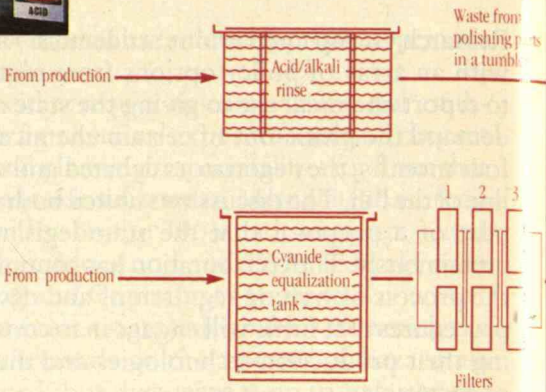
Substituting material inputs: Firms can substitute less toxic materials for more toxic ones either in a final product or as intermediaries in production. Substituting water-based cleaning agents for chlorinated solvents is one example. Many major newspapers have substituted soy-based ink for petrochemical-based ink in color printing, thereby shortening cleanup time, cutting hazardous waste, and improving working conditions.

Reformulating processes: Redesigning production equipment or processes can reduce the need for toxics. For example, simple mechanical processes can replace some that depend on toxic chemicals. The Air Force blasts plane bodies with reusable plastic pellets to eliminate the need for hazardous paint-removing solvents before repainting. Automating production processes such as scheduling, temperature control, or metering chemical additives can reduce toxics use by improving yields and lowering the proportion of products that don't meet specifications.

Redesigning products: Better product designs can reduce toxic constituents or the need for chemicals in processing. For example, "natural color" paper and low-chlorine white paper, both of which are marketed as environmentally friendly, reduce the need for chlorine in pulp and paper processing. In Switzerland, the Product Life Cycle Institute has developed criteria for extending product durability, repairability, and reusability, all of which conserve energy and resources and reduce toxic chemical use and waste.

Improving operations and maintenance: Simple improvements in housekeeping, storage, and handling or in maintaining equipment can help. Better monitoring can catch leaks and emissions from equipment. For example, careful attention to pressure levels in spray surface coating can prevent overspraying.

Recycling in-process substances: Production methods that recycle, clean, or reuse chemicals lessen the amount of feedstock required. "Closed loop" processes, such as those being implemented in electroplating, continually clean and reuse plating baths. However, sending chemicals to commercial recyclers does not constitute toxics use reduction because it doesn't necessarily reduce toxics use. ■



The Robbins Co., a jewelry manufacturing and plating company in Attleboro, Mass., saves $71,000 a year with a closed-loop wastewater treatment and recovery system that went into full operation in February 1988.

tion] implies that emissions to the environment are to be avoided wherever possible," explains Konrad von Moltke, a specialist on European environmental policy. Von Moltke notes that there is no mention of assimilation or thresholds. "Even when no environmental effects are discernable, the avoidance of emissions is preferable to allowing them to occur."

Precaution shifts the burden of proving safety from those who would protect the environment to those who would release chemicals into it. And like toxics use reduction, it bases decisions about releases on available options, not on the environment's assimilative capacity. The new adage is "When in doubt, don't throw it out."

Clean Technology

Prevention, precaution, and toxics use reduction direct industrial practice away from high-risk procedures. Still, there remains a need for transitional steps that would move current industries into more sustainable production systems. Toward fulfilling this need, several European nations have taken up the idea of clean technology, a phrase that became common in Germany, Denmark, and the Netherlands in the mid-1980s.

In contrast to "add-on" or "clean-up" technology, clean technology consists of low- or no-waste production equipment that conserves energy and materials. The Commission of the European Communities, recognizing the multiple components of the concept in 1985, defined clean technology as "any technical measure taken . . . to reduce, or even eliminate at [the] source, the production of any nuisance, pollution, or waste and to help save raw materials, natural resources, and energy."

The governments of France, Germany, Denmark, Norway, Finland, and the Netherlands have all taken steps to promote clean technology. In some countries, these measures include disseminating information and providing economic incentives, such as research subsidies and tax savings. Other countries have gone further and created official bodies to promote clean technology, invest in research, and adjust regulations so industry can more easily adopt cleaner modes of production.

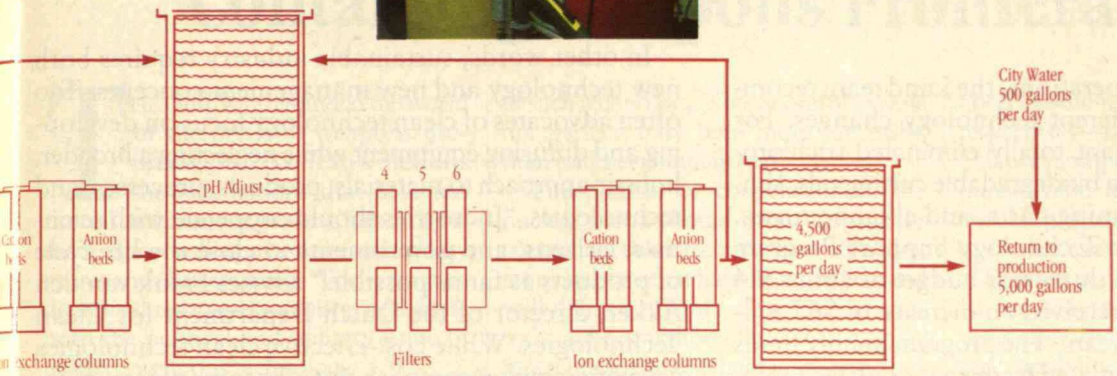
France has established a Clean Technology Commission to coordinate promotion and development efforts. In 1984, the commission provided about $3.4 million to 60 pilot projects ranging from recycling solvents and reclaiming used oil to redesigning electroplating tanks and plating operations. A survey of over 600 French clean-technology projects conducted by the Organization for Economic Cooperation and Development (OECD) found that 67 percent saved on raw materials, 65 percent conserved water, and 8 percent cut energy use.

In the Netherlands, the Department of Clean Technologies in the Ministry of Housing, Physical Planning, and the Environment promotes the idea in existing industries and encourages the development of clean-technology processes and products for export. As part of their national environmental policy, the Dutch have established a program that requires a firm to assess the environmental impact of its products throughout their useful life and during their disposal. The Dutch government is also funding research into substitutes for CFCs, chlorinated pesticides, cadmium-bearing fertilizers, and asbestos.

Of particular note is a regional clean-technology program set up near Rotterdam and Amsterdam by the Netherlands Organization for Technology Assessment. The program focuses on 10 firms and 35 priority areas for clean-technology options. So far, 45 projects have been implemented, including the elimination of several rinsing operations, a transition to cyanide-free electroplating, purchasing new packaging equipment, and replacing resin sampling systems. Twenty of the projects have saved money; the others didn't affect cost.

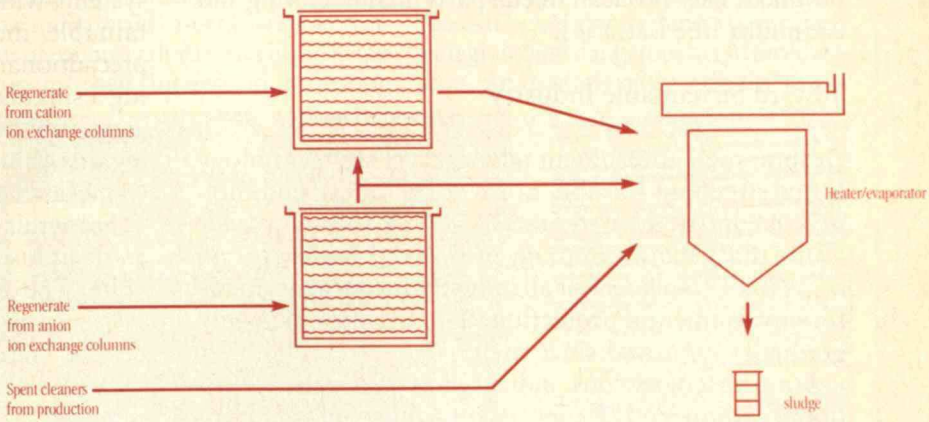
One of the best-documented experiments in clean technology began in Landskrona, Sweden. Researchers from a technical institute at the University of Lund identified seven small to medium-sized companies for an intensive clean-technology program. After thorough-

PHOTOS: L. BARRY HETHERINGTON



Wastewater Purification Subsystem

In the purification subsystem, hydrogen peroxide destroys cyanide. Progressively smaller particulate filters remove solids like dirt and oils, and carbon filters remove organic compounds. Ion exchange resins remove salts and metals. Sodium hydroxide is used to adjust the pH in spent acids, and muriatic acid does the same for bases. The water that returns to production is 40 times cleaner than city water and thus improves the quality of Robbins's plating process. Since the subsystem contains parallel filters and resins, manufacturing doesn't stop for preventive maintenance.



Metal Recovery Subsystem

Ion exchange resins from the wastewater subsystem produce "regenerate" laden with metals. In the second subsystem, this regenerate goes to separate cation and anion storage tanks. The two streams later combine in an evaporator where water is boiled off, leaving more metal and a small amount of salt sludge—7 gallons per year, all of which is recovered, compared to 4,000 gallons per year in 1986, all of which was landfilled. The sludge, resins, and some filters go to recyclers for further reclamation of base and precious metals.

Annual Savings in 1989 over 1986

ITEM	PERCENT REDUCED	SAVINGS
Water use	47.7	$18,000
Wastewater treatment chemical use	81.8	$ 8,000
Hazardous waste disposal	89.0	$14,000
Laboratory analysis costs	86.9	$26,000
Regulatory fees	—	$ 5,000
ANNUAL SAVINGS		$71,000

Payback Period: 1.69 years

DIAGRAM BY: CARRI MULLANEY

The transition to clean production offers an opportunity to unite human health and industrial productivity.

ly analyzing current operations, the Lund team recommended over 100 different technology changes. For example, one lamp plant totally eliminated trichloroethylene by changing to biodegradable cutting oils, simple detergents for cleaning parts, and alkaline rinses.

Denmark's Cleaner Technology Support Program started in 1987 with a three-year budget of about $14 million and last year received an increase to $62 million for another three years. The program mainly funds pilot projects, many initiated by the national Technologisk Institute, in the metal, wood products, and food industries. It also supports projects that seek replacements for CFCs and mercury and other heavy metals.

At the regional level, the European Community has established an information clearinghouse to advise firms on adopting clean technology and to promote the adoption of low-waste equipment. For several years, the EC has also awarded prizes for clean technologies and products, like "no clean" metal parts manufacturing and cadmium-free batteries.

Toward Sustainable Industry

Despite such government advocacy, clean technology is not sweeping Europe, nor is it becoming common practice in the United States. A 1987 OECD survey found that clean-technology projects accounted for no more than 20 percent of all industry investments made for environmental protection. The situation has only gradually improved since then.

For a host of reasons, industry has preferred conventional add-on (end-of-pipe) technology to installing entirely new production equipment. Paralleling the findings of the U.S. Office of Technology Assessment, the OECD found that add-on equipment tends to cost less up front, even if process changes save money over the long haul. Add-ons are also readily available, and distributors prefer selling such devices, which often come with service contracts. Add-on equipment is often widely accepted and well proven, so officials accept its purchase as a sign of strong intentions to comply with regulations. Finally, add-ons don't affect production much and can fail without disrupting it, but faulty process equipment can slow or shut down an entire production line.

While many of the advantages of add-ons reflect the conservatism of managers, some are due to limited experience with clean technologies. For sustainable industry to take hold, then, manufacturing will need information on how to implement clean technologies as they become available.

In other words, sustainable industry requires both new technology and new management concepts. Too often advocates of clean technology focus on developing and diffusing equipment while neglecting a broader, holistic approach to materials, products, processes, and technologies. "Industries should cooperate with scientists, citizens, and governments to close the life cycle of products as far as possible," advises Frank van den Akker, director of the Dutch Department for Clean Technologies. While cost-effective clean technologies can sometimes accomplish this, "in some places, completely new production technologies and a new structure and way of living have to be worked out."

Sustainable industry encompasses the entire social, economic, and technological system by which we produce goods. This expansive context is also called "clean production," a term coined at a 1989 meeting of the United Nations Industry and Environment Program on low-waste and no-waste technology. The systems-wide perspective of clean production and sustainable industry merges prevention policies, the precautionary principle, and clean technology. Eschewing a singular focus on wastes, materials, or technologies, it unites these elements into an integrated view that regards economic and environmental goals as equal determinants of a healthy society.

From this point, it is a short jump to considering the entire industrial system as an environmental and health issue. The design of new production processes would take into account both occupational and community health. The consumption of materials, water, and energy would be evaluated in determining production efficiencies.

In short, policies to promote sustainable industry would consider the risks of materials throughout their full life cycle—from synthesis or extraction through processing, distribution, and application to final disposal. The use of existing materials would be carefully tailored to fit into natural ecological systems. The design and selection of new materials would be consciously directed toward enhancing the quality of the environment and public health.

The materials revolution of the twentieth century brought forth a cornucopia of products, yet in the rush to supply markets there has been less-than-adequate accounting for the risks either to people or to nature. The transition to clean production offers an opportunity to unite human health and industrial productivity. The challenge for sustainable industry is to develop the knowledge, techniques, and materials to guarantee that tomorrow's enterprises are as safe and clean as they are productive. ■

Containing Weapons Proliferation

THE Gulf War reminded the world of the perils of weapons proliferation. As Iraq's actions showed, nations that have territorial ambitions or perceive insecurity in their region will aggressively seek to buy more and better arms. The war also demonstrated to every ministry of defense both the political and military value of modern weapons technology.

More than a dozen nations are developing or producing ballistic or cruise missiles of significant payload and range, either for their own use or for export. The United States and many other countries sell advanced conventional military systems, such as precision-guided munitions and electronic warfare equipment.

It is now widely believed that three nations beyond the six declared nuclear weapons states, have a nuclear capability, and the number is growing. Concern is also growing over the spread of chemical and biological weapons, especially in the Middle East; that Iraq refrained from using chemicals should not lull us into complacency.

Disturbingly, the pace of military technology transfer and arms sales appears to be increasing. U.S. and Western European industries face declining defense budgets and are vigorously pursuing international markets. The Soviet Union, Eastern European countries, and China see arms sales as an important source of hard currency. Indeed, the very existence of excess capacity for weapons production encourages proliferation.

This combination of demand and supply for military technology weighs against the prospects for controlling proliferation. But the United States can combine several instruments of foreign policy—arms limitation agreements, export controls, diplomacy, and military and economic aid—to slow the process and perhaps avoid more destructive conflicts in the future.

Of the various types of arms, the United States has accumulated the most antiproliferation experience with nuclear weapons, where a small group of supplier nations has reached a political consensus that enables them to control the export of such technology. These controls, while not perfect, have been more successful than had been anticipated.

The pattern of cooperation in the nuclear arena should prove helpful for controlling other technologies—missiles, for example—that have few suppliers and well-defined military uses. Export controls will prove more difficult to employ for technologies that have many suppliers and both commercial and military uses. This category includes chemical and biological agents, as well as radar and communications technologies.

A major difficulty is that exporting countries will, quite properly, try to help their friends. The United States, for instance, will continue to provide arms to Israel. Supplier nations will argue, with considerable justification, that conventional military aid eases the security concerns of countries that receive it and hence dampens their interest in acquiring nuclear, chemical, or biological weapons. And anti-proliferation efforts will sometimes be pushed aside by other strategic goals. In a particularly frustrating case, U.S. efforts to gain Pakistan's cooperation during the Afghan war overrode earlier attempts to slow Pakistan's entry into the nuclear club.

The United States should take a leadership role among supplier nations in slowing the spread of new military technology. First, policymaking needs to occur higher up the governmental ladder. At present, the responsibility for export controls is split among three departments—State, Commerce, and Defense. These agencies have different priorities—good relations, good business, and military advantage, respectively—that sometimes conflict. To balance competing interests and stifle bureaucratic differences, the president should delegate authority over export control policy to the national security adviser.

Second, proliferation controls should be focused as narrowly as possible on technology that relates to important military capabilities. As we learned in the efforts to control exports to the Soviet Bloc, restrictions on dual-use technology are ineffective and incur political costs disproportionate to their benefit.

Third, the United States should pursue nonproliferation as a multilateral endeavor. Unilateral moves are likely only to disadvantage domestic industry.

There will be occasions, however, when a leadership role will require the United States to stand alone against a particularly egregious and dangerous act of proliferation. An example of the effectiveness of such leadership occurred in the early months of the Carter Administration, when I saw a few talented officials focus world attention on the problems that could arise from uncontrolled commerce in nuclear technology. The ultimate result was the formation of the Nuclear Suppliers Group, which has successfully controlled the export of sensitive nuclear technology. In critical cases, the United States should not underestimate its ability to take effective worldwide action. ■

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PHOTO OF JOHN M. DEUTCH BY L. BARRY HETHERINGTON

Fear and Loathing on the Nuclear Bandwagon

ON the TV screen flash chilling images of Saddam Hussein, the Ayatollah Khomeini, and Muammar Qaddafi beckoning to crowds of fanatical supporters. Here are the people Americans are supposed to hate. In the background, Bill Withers sings the mournful hippie anthem of yesteryear, "Lean on Me." A soft-spoken announcer explains, "There are some people in the world you do not want to depend onBut the more we use nuclear energy instead of imported oil to generate our electricity, the less we have to depend on unstable sources."

This eye-catching but tasteless ad, prepared by a pro-nuclear organization, ran on cable television during the weeks following the Gulf War. Its underlying message: If you think nuclear power is frightening, just look at these ogres. At a time when the nation is beginning to reassess post-war energy priorities, it is disheartening to see the nuclear advocates sink so low, pandering to fear and chauvinism.

Such tawdry propaganda seems curiously at odds with the mood of upbeat self-confidence the nuclear power industry has tried to project recently. Newspaper stories proclaim that the nuclear option is back in favor with decision makers. There are said to be fewer malfunctions at nuclear plants, less radiation exposure to workers in the industry. Optimistic reports describe blueprints for a future generation of reactors said to be inherently safe. A *Time* magazine cover story suggests that the nation has no choice but to return to nuclear power.

Amplifying this renewed excitement, President Bush's energy plan identifies nuclear as its preferred "alternative" for the future. Congressional leaders, eager to reduce U.S. dependence on Middle East oil, seem prepared to endorse the administration's request for $430 million to support nuclear research, development, and industry subsidies in 1992.

A major barrier to the new nuclear bandwagon, however, appears to be the U.S. public. Opinion polls show a steady decline in public approval of nuclear power since the mid-1970s. Even after the shock of the Gulf War, some 60 percent of respondents to a *Time*/CNN survey said they would oppose building a nuclear plant in their community, and a majority opposed nuclear power regardless of the reactor's location.

Proponents of nuclear power hope to sway popular sentiment to support the industry's resurrection. They are not, however, eager to involve citizens in making real decisions. The Bush administration is now pushing measures that would drastically limit public participation in the nuclear licensing process, eliminating the second of two hearings now required as plants are built.

Over the years, citizens' groups and state and local governments have used these hearings to examine crucial issues of nuclear safety, such as emergency planning, fire protection, quality control, and the ability of a plant to withstand earthquakes. These hearings have slowed the building of several plants, including the ones at Seabrook, N.H., and Diablo Canyon, Calif. Public concern eventually halted the building of the Shoreham, N.Y., plant altogether.

What the bombastic TV spots and licensing maneuvers reveal is hardly an industry bursting with self-confidence, but one involved in a desperate struggle for survival. The last firm order for a nuclear plant occurred when Richard Nixon was still in the White House. In light of its history of cost overruns and bankruptcies, nuclear power is still regarded by Wall Street and most utilities companies as a poor investment. Seabrook's parent utility went bankrupt, and the Washington Public Power Supply System (WPPSS) defaulted on its bonds and has had to dismantle two partly constructed reactors.

Even though people are painfully aware that the nation's petroleum addiction stands at the root of the Gulf War, the Exxon Valdez disaster, and the specter of global warming, they still associate nuclear power with Three Mile Island, Chernobyl and utility companies' financial meltdowns. The costs and hazards of nuclear waste disposal remain a focus of bitter controversy. Nuclear power lingers in the public mind as the engineering equivalent of junk bonds and the savings and loan debacle.

It is possible that the public is out ahead of our energy policymakers on this question, already prepared for substantial changes in policies and energy-related lifestyles. In a recent survey conducted by Vince Bregglio and Celinda Lake, pollsters for the 1988 Bush and Dukakis campaigns respectively, 75 percent of the respondents listed renewable energy as their first or second choice for new funding. In the lackluster Bush energy plan, however, renewables and conservation receive scant attention.

Rather than try to frighten or sandbag the American people on questions of energy policy, perhaps our leaders ought to listen to them for a change. ■

LANGDON WINNER is visiting research scholar at the Center for Technology and Culture in Oslo, Norway. His most recent book is The Whale and the Reactor.

PHOTO OF LANGDON WINNER BY L. BARRY HETHERINGTON

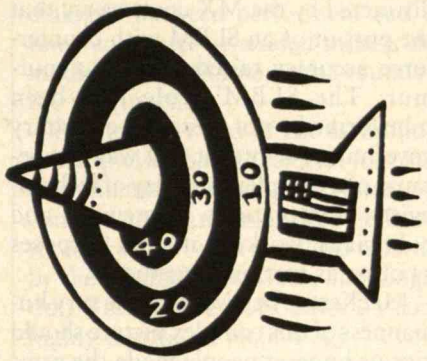
Reviews

BOOKS

BIRTH OF THE BERYLLIUM BABY

Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance
by Donald MacKenzie
MIT Press, $29.95

BY MATTHEW BUNN



DEEP within the giant MX ICBM, the most advanced U.S. land-based nuclear missile, lies a precisely machined beryllium sphere, floating warmed and protected in a fluid bath. The obvious analogy to a fetus in the womb led its engineers to dub this remarkable inertial guidance system, with its complex set of accelerometers and gyroscopes, "the beryllium baby." In contrast to the laser-guided bombs of the Gulf War, the beryllium baby operates without external references: like a blind person feeling the stops and turns of a bus, it navigates by sensing the missile's accelerations and changes of orientation. Yet the system can direct the MX's nuclear warheads to land within the length of a football field a quarter of the way around the world—equivalent to threading a needle a hundred meters away.

This remarkable technical feat has profoundly troubling implications. Because each of the MX's 10 warheads carries an explosive punch some 20 times that of the bomb that leveled Hiroshima, such accuracy is hardly necessary for striking a city, a factory, or most military bases. Only if one wants the missiles to strike "hardened" targets—primarily their brethren on the other side, buried in concrete-and-steel silos—is pinpoint accuracy needed. But the silos would probably be empty by the time a retaliatory blow arrived, so this "counterforce" targeting is most useful for a nuclear first strike. The more each side's missiles are threatened by such an attack, the more each side will be tempted to rely on hair-trigger strategies—to "use them or lose them"—increasing the risk that a crisis might escalate to nuclear war.

Donald MacKenzie's masterful history of inertial guidance, *Inventing Accuracy,* tells us how this precision, with all its frightening ramifications, came to be. (Readers who, like me, are always mystified by the way a gyroscope responds to torques may still want to have a toy one on hand for consultation.) MacKenzie also describes what can be publicly known of Soviet missile guidance—a surprisingly great deal—and elucidates the tricky process of translating test-range results into accepted "facts" about missile capabilities. Much of the story unfolds at MIT, for the organization that guidance guru Charles Stark Draper founded—once known as MIT's Instrumentation Lab, now the independent Draper Laboratory—designed most of the key guidance systems for U.S. missiles, including the beryllium baby.

But guidance technology itself is not MacKenzie's main focus. As an analyst of the social history of technology, his goal is to "undermine the big determinisms, technological and political." The accuracy of the beryllium baby and its only slightly less impressive Soviet counterparts, he argues, is not the inevitable result of technological progress, of a natural "technological trajectory"; nor was it foreordained simply because powerful states demanded accurate missiles with which to implement their chosen nuclear strategies. Instead, missile accuracy "is the product of a complex process of conflict and collaboration between a range of social actors including ambitious, energetic technologists, laboratories and corporations, and political and military leaders and the organizations they head." This process, he writes, "has fueled, and has itself been fueled by, the cold war." Accepting either sort of determinism, Mackenzie argues, leads to a passive fatalism. But "to see the mundane social processes that form the nuclear world is to see simultaneously the possibility of . . . reshaping that world."

Reversing Misconceptions

MacKenzie's case against technological determinism rests on three pillars, each nearly sufficient in itself. First, he points out that not all missile powers have followed the "trajectory": while U.S. and Soviet nuclear missiles have become steadily more accurate, French and Chinese missiles have remained inaccurate "city-busters." (The British buy their nuclear missiles from the United States, while providing the warheads themselves, and thus do not provide an independent case.)

Second, MacKenzie shows that in commercial navigation, the other major area in which inertial guidance is widely used, accuracy has not substantially improved for decades. Instead, the focus has been on economy, producibility, and reliability. Draper tried to convince the users of aircraft navigation that they needed his expensive and finicky precision instruments, but had much less success than he had with the Navy and the Air Force.

Third, MacKenzie describes a case in which the political process led to an explicit decision to make a missile—the Poseidon sea-launched ballistic missile (SLBM)—less accurate than it could otherwise have been, precisely to avoid posing a first-strike threat. A path that neither other powers nor other users

ILLUSTRATIONS: MARY ANNE LLOYD

have followed, and that can be temporarily blocked by a political decision, can hardly be described as the inevitable trajectory of technology.

The Poseidon episode, as well as the broader story of the changing role of the U.S. sea-based deterrent, also refutes the other deterministic argument: that ever-greater accuracy was a simple matter of government demand. SLBMs began as an "ultimate deterrent" that would lurk invulnerably beneath the oceans, always available to deliver a final retaliatory deathblow. That mission did not require great accuracy. In the early 1960s, the Navy's Special Projects Office consciously avoided pursuing accuracy, even though Secretary of Defense McNamara and top Navy officials argued to the contrary. That way, Special Projects was able to avoid trespassing on the Air Force's counterforce territory.

But in the late 1960s, as the new Poseidon missile was being defined to replace the first-generation Polaris SLBM, some guidance technologists persuaded the Pentagon to include "stellar-inertial" guidance—a means of correcting errors through star sightings—as an option. But this explicitly counterforce-oriented accuracy program raised a storm of controversy in Congress, where opponents of "first-strike weaponry" were then strong. The program was soon abandoned, leaving Poseidon without stellar correction.

Stellar-inertial proponents learned their lesson. When the next SLBM, the Trident I, came along, stellar-inertial guidance was justified not as *improving* accuracy but as *maintaining* it over a longer range, giving the submarine more ocean to hide in. This argument was apparently accepted with little remark on the obvious fact that Trident I would be far more accurate than its predecessor when compared over the same range.

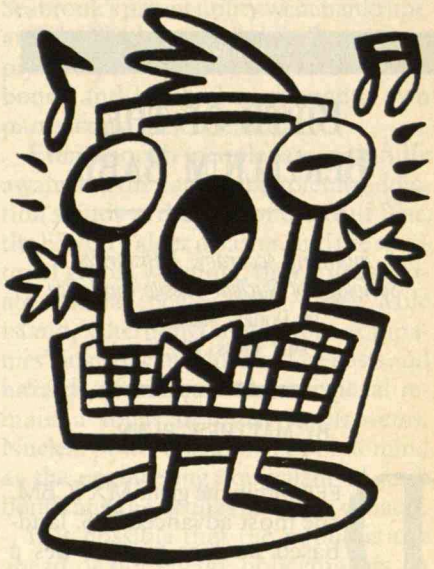
By the time the Trident II arrived, stellar-inertial guidance was technically established, Special Projects was no longer worried about stepping on Air Force toes, and counterforce opponents in Congress were so weakened and so distracted by the MX controversy that the pursuit of an SLBM with counterforce accuracy raised scarcely a murmur. The SLBM's role had been transformed—not because a unitary government wanted it that way but because of a complex interplay of technologists, corporations, strategists, and politicians, working at cross purposes as often as working together.

MacKenzie believes that the very humanness of this complex picture should give us hope: if people made the arms race, people can unmake it. This optimism is particularly apparent in an epilogue titled "Uninventing the Bomb," written in the euphoria that followed the collapse of the communist regimes in Eastern Europe. Here MacKenzie argues for the necessity and feasibility of a "world permanently free of nuclear weapons."

Now, with even limited reductions in strategic arms just barely limping toward completion, hope for a nuclear-free world seems misplaced. That missile accuracy and the rest of the arms race were not inevitably determined by technology or by statecraft does not demonstrate that they can readily be reversed. As Kafka showed us, the human webs of bureaucracy and politics can be virtually impossible to conquer, even with reason on one's side.

But sweeping changes in our nuclear posture are both needed and possible. Sustained public pressure for deep cuts in the current arsenals of overkill can greatly improve the prospects for accord. So, too, can a drive for qualitative restraints on new weapons—such as a ban on precision-guided maneuvering warheads, which would deliver even greater accuracy than the beryllium baby. By illuminating a critical part of how we got here, MacKenzie has laid the groundwork for mapping our way to a safer world. ■

MATTHEW BUNN, editor of Arms Control Today, *is the author of* Foundation for the Future: The ABM Treaty and National Security *(Washington, DC: Arms Control Association, 1990). He wrote* Technology Review*'s January 1988 cover story, "The Next Nuclear Offensive."*



MUSIC

SYNTHETIC SOUND, REAL PEOPLE

Music from the MIT Media Lab for Live Instruments and Interactive Computers
Symphony Hall, Boston, February 24, 1991

BY WILLIAM ELDRIDGE

ALARMED by certain composers' rash statements, many music lovers in the late 1940s and early 1950s worried that computer music would make the performer obsolete. In fact, music emanating from nothing but loudspeakers soon revealed serious limitations. Concert audiences like to have something to look at besides speakers, preferably a human performer. What's more, performances of a composition for computer-generated tape alone never vary, and hence are less interesting for the composer as well as the audience.

Within a few years, composers such as Edgard Varèse, Bruno Maderna,

Vladimir Ussachevsky, and Otto Luening had begun to create works for tape in conjunction with live performers. This approach combines the expanded sound world of electronic music with the spontaneous interpretive magic (and the electrifying possibility of failure) one or more live musicians can provide.

Since then, technologies for merging human-produced and electronic sounds have grown in number and sophistication. A concert presented earlier this year at Boston's Symphony Hall by the new-music ensemble COLLAGE and the MIT Media Lab provided a sonic snapshot of the genre's current level of development. All the composers on the program have been associated with the Media Lab's Music and Cognition Group, one of the world's foremost centers of computer music composition and research.

While the concert proved that composers and technicians have managed to overcome many pitfalls of combining human and electronic performers, it also evinced an unfortunate trend in contemporary music: as composers delve into fancy interactive computer software, they often seem to abandon the quest for new sounds that inspired the marriage of music and electronics in the first place.

Not all the compositions on the program rely on dazzling technology. An example is Peter Child's *Ensemblance,* an elegant, assured, and fascinating work soon to be released on a Neuma Records compact disc. Like many earlier works in the genre, it is scored for instrumentalists—flute, clarinet, violin, viola, cello, two percussionists, and piano—and computer-generated tape. But unlike many such works, it deals effectively with an inherent problem of the medium: the need for performers to coordinate with the fixed timing of the prerecorded tape, which limits their spontaneity and flexibility. Childs has combined tape and instruments so skillfully that the tape part seems to be an active participant. Instead of simply juxtaposing the two elements, he has integrated them, creating the illusion of a dialogue between performers and refined computer-generated sounds that modify and elaborate on the sounds of the instruments.

At the other end of the technology spectrum was *Banff Sketches,* for piano and interactive computer system. Its composer/programmer, Robert Rowe, recently received the first PhD awarded by the Media Lab's Music and Cognition Group. The work relies on some highly innovative technology—a computer program that improvises in response to the piano part. But it too has historical roots, namely in a tradition of attempts to combine live performers and real-time electronic sounds. This approach permits a kind of interplay that tape can only simulate.

Live electronic performances became possible in the 1960s with the arrival of voltage-controlled analog synthesizers developed by Robert Moog, Donald Buchla, and others. The first such instruments had some notorious drawbacks. For one thing, they required hours to set up. Sound modules had to be connected with a spaghetti tangle of patch cords, and dozens of knobs had to be twiddled and tweaked. As it's impossible to reproduce exact knob settings, a composer's sound designs could only be approximated from performance to performance (although some composers saw this as a virtue).

The digital performance synthesizers that began appearing in the 1980s could call up preprogrammed sounds almost instantaneously and, unlike their predecessors, always stayed in tune. Because of these obvious benefits, they were rapidly embraced by serious composers as well as rock musicians. Something precious had been lost, however: the knobs.

Despite their lack of precision, knobs give instant access to all the parameters of a sound, allowing a performer to vary them subtly or dramatically with a twist of the wrist. But with most digital synthesizers, the performer can control only one parameter at a time, calling up its numerical values on a small display and changing the numbers individually. While this makes for an elegantly simple front panel design consisting of only a few buttons and sliders, it drastically limits the expressive potential of the instruments. Fortunately, if somewhat belatedly, some synthesizer manufacturers have begun to address this problem by crowding their front panels with variable knobs and sliders.

But even with more knobs, the current generation of digital performance synthesizers and small computers can't begin to approach the degree of refinement and control over the structure of sound possible in a studio setting, where computing time is virtually unlimited. This may change soon as the price of ultrafast "RISC" (reduced instruction set computing) workstations drops, and as composers and engineers at the Media Lab and elsewhere develop special-

ized signal processing cards. Software-based synthesis and signal processing that previously took hours of computation will be possible in real time.

For Rowe, the hardware of choice was a Macintosh computer, which he programmed to listen to and interact with the MIDI output from a Yamaha Disklavier piano. MIDI, the Musical Instrument Digital Interface, is a standardized data protocol that permits synthesizers and other MIDI devices to communicate with computers and each other. The computer can act upon the music a performer plays, transforming it in a variety of ways such as turning it upside down (changing an ascending pitch into a descending one) or expanding small leaps into large ones.

In *Banff Sketches,* the computer monitors aspects of the musical performance—its range and speed, as well as the specific notes played—and responds with music of its own, transforming the pianist's material. The computer's flexibility provides for a degree of freedom in the pianist's interpretation of the work. Indeed, several sections of *Banff Sketches* call for the pianist to improvise, so the computer will respond differently with each performance.

For the listener, the interest in this type of procedure lies in making aural connections between the live material and the computer's response. Unfortunately, many of the computer-generated transformations in *Banff Sketches* were so complex as to obscure these relationships, especially as the piano music itself had a dense, knotty texture. The impression created was of 1990s technology in the service of the stale post-Webern academic modernism of the 1960s.

Another work on the concert—Jonathan Harvey's *From Silence,* soon to appear on a Bridge CD—successfully fuses the two traditions to which Rowe's and Child's compositions belong. It combines live "acoustic" performers (soprano, violin, viola, and percussion) with live synthesis (three electronic keyboards) *and* computer-generated tape. Having human performers control the keyboards allows the synthetic sounds to participate as normal members of the ensemble, following the conductor instead of the other way around. At the same time, the use of tape has given the composer an opportunity to generate long, evolving sounds and textures impossible with real-time synthesizers.

Perhaps the most technically involved work was *Towards the Center,* by Tod Machover, whose composition *Flora* (for taped voice) was also on the program. Still only in his 30s, Machover has achieved a level of renown and popular appeal rare for a serious composer of art music. His high-tech science-fiction opera *VALIS* played to sellout crowds in Europe and the United States, and the recording of the opera on the Bridge label has received unusually strong sales. His crossover appeal to nonclassical audiences most likely comes from his occasional incorporation of elements of rock music into his style, especially a strong harmonic bass line and a constant, propulsive beat.

Towards the Center (available on Bridge compact disc BCD 9020) is a major work lasting almost 20 minutes. It is scored for flute, clarinet, violin, cello, "hyperpercussion," and "hyperkeyboard." Machover's "hyperinstruments," created in collaboration with programming whiz Joseph Chung, use MIDI keyboards, guitars, or mallet controllers—which may or may not produce sound themselves—to send musical information to a computer. The computer acts on the input in various ways, ultimately controlling a bank of devices that produce synthesized and sampled (digitally recorded) sounds. In *Towards the Center,* this permits two players to produce rapid virtuoso flurries of perfectly timed notes that would otherwise be impossible, and lets both hyperinstrument players combine to control different aspects of a single part, such as volume and timbre.

Machover's hybridization of "modern classical" and rock music, while popular with general audiences, is controversial among his fellow composers, some of whom feel he is selling out. Machover seems sincere, though, and rock is surely as legitimate an influence for a young American composer as Hungarian folk music was for Bartók.

Listen to My Notes

What *is* troubling is the generic commercial synthesizer sounds Machover usually employs, even to the extent of using the drum machines ubiquitous in current popular music. To a greater or lesser degree, this complaint could be lodged against Rowe and many other composers working in the sexy, state-of-the-art area of interactive computer music. Composers seem to pour so much time and energy into programming the computer interaction that they

have nothing left for the sonic exploration—the new *sounds*—that used to be the primary concern of electronic composers.

Synthesized sound grew out of the futuristic dreams of a few composers like Edgard Varèse (1883–1965). As early as 1917 Varèse wrote, "I long for instruments obedient to my thought and which, with their contribution of whole new worlds of unsuspected sounds, will lend themselves to the exigencies of my inner rhythm." Sympathetic engineers and designers over the years worked closely with art composers to develop the tools required to explore these new worlds.

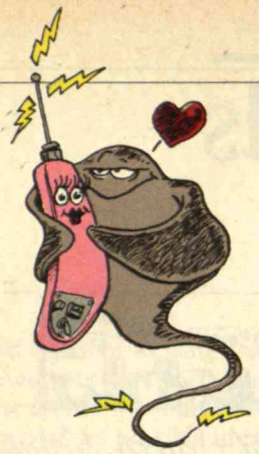
But beginning in the 1970s, rock musicians started to use synthesizers for their novelty value, and today what was novel has become routine. The requirements of pop musicians have become the driving force in the development of this technology—and all too often lately, rock-driven technology has in turn driven the music of serious composers. MIDI, with its orientation toward discrete note-events, discourages the large gestures—whale-like or other extended, fluid sounds—that sometimes characterized older electronic and computer music. Commercial keyboard synthesizers, which can be programmed to produce quite a range of "unsuspected sounds," tend to be used superficially. It is as if the composer were saying, "Listen to my (and my computer's) notes; the sounds are incidental."

In this sense, as exciting as it is that live performers can now interact with synthetic sounds instead of performing in lock step with a tape, electronic music seems to have taken a leap backwards. Let us hope that composers, with the aid of the next generation of computer music technology, will soon return to Varèse's vision of an infinite universe of possible sounds. ■

WILLIAM ELDRIDGE received his PhD in composition from Harvard University and has written a variety of instrumental and electronic works. In the fall he will become the founding director of the Boston Conservatory Computer Music Studio.

Classifieds

Notes



Electric Love

Along a remote stretch of Mexican coast, weak electric fields help round stingrays find romance. During courtship, "electroreception" alerts male fish to the presence of potential mates, who hide themselves by burrowing in the sand.

It has long been known that rays can detect electric fields, but no one connected that with social behavior before, says Timothy Tricas, a sensory neurobiologist at Washington University. Using electric signals recorded from rays in his lab, Tricas developed a "model ray." He took his model to a breeding site in Mexico and, in over 100 experiments, males detected the dummy and responded to its signal.

Sickle Cell Advance

Scientists at Lawrence Berkeley Laboratory have created mice whose red blood cells will respond to the same conditions that cause red cells to deform in humans with sickle cell anemia. The disease afflicts 1 out of every 400 black people in the United States.

Edward Rubin, who led the development of these "transgenic" mice, says they should help researchers understand sickle cell anemia and test experimental treatments for it. The illness results from a mutant form of hemoglobin, the protein in red blood cells that carries oxygen from the lungs to the rest of the body. Sometimes this mutant protein will form a rigid chain that may distort a blood cell into the shape of a sickle. Since these cells can't squeeze through capillaries they impair the flow of blood.

Doctors and AIDS

A Tufts University medical ethicist believes that many physicians, particularly senior surgeons, resist caring for people who test positive for HIV, the virus that causes AIDS. Writing in *Hastings Center Report,* philosopher Norman Daniels speculates that doctors fear both contracting the disease themselves and losing patients who would shun their offices if AIDS patients were treated there.

Daniels says denying care, particularly surgery, to AIDS patients has stirred up a tempest among the lower tiers of medical professionals—notably nurses, interns, and residents. Daniels writes that these people could become, by default, the principal care providers for AIDS patients, thus creating a double standard for treatment.

Unfrozen Fish

Thomas Caceci thinks winter flounder hold the key to one way of keeping citrus crops from freezing and ice from forming on highways or airplanes. With his colleagues at Virginia Tech University's College of Veterinary Medicine, Caceci has produced a synthetic version of the peptide that enables the flounder to withstand water as cold as 27°F.

At an American Chemical Society meeting, Caceci said the antifreeze compound could lead to a cheap, biodegradable alternative to road salt. And since the synthetic peptide molecules are twice as large as natural ones, they might work at lower temperatures.

Uncut Valuables

Fruits, rubber, spices, exotic plants, and even the raw materials for pharmaceuticals might make some tropical forests worth more uncut than cut. Research by Yale University forestry expert Robert Mendelsohn indicates that harvesting these items might often yield more profit than chopping down trees and using the land for farming or grazing.

Mendelsohn has called for further research on what marketable products each tropical forest could yield and what markets old products might command. In one study conducted by the Yale researcher and his colleagues, the financial return from rubber, oils, and edible fruits on five acres of Peruvian tropical rainforest was twice that from five acres where trees were cut. "The secret to making a living from the forest," he explains, "is to exploit its natural diversity by selling many, many products."

Space-Age Firefighting

NASA Ames Research Center and Terra-Mar Resource Information Services, Inc., both of Mountain View, Calif., are working to merge topographical and vegetation data with live views of forest fires. The resulting "picture" would enable firefighters to see through a smoky forest fire.

The system will draw on remote databanks to retrieve maps of land cover, roads, and water sources, and it will combine this information with up-to-the-minute aerial images of the fire. The resulting digital representation of a blaze's intensity and borders, overlaid with drawings of roads, water sources, and map coordinates, could be transmitted to a ground station near the fire.

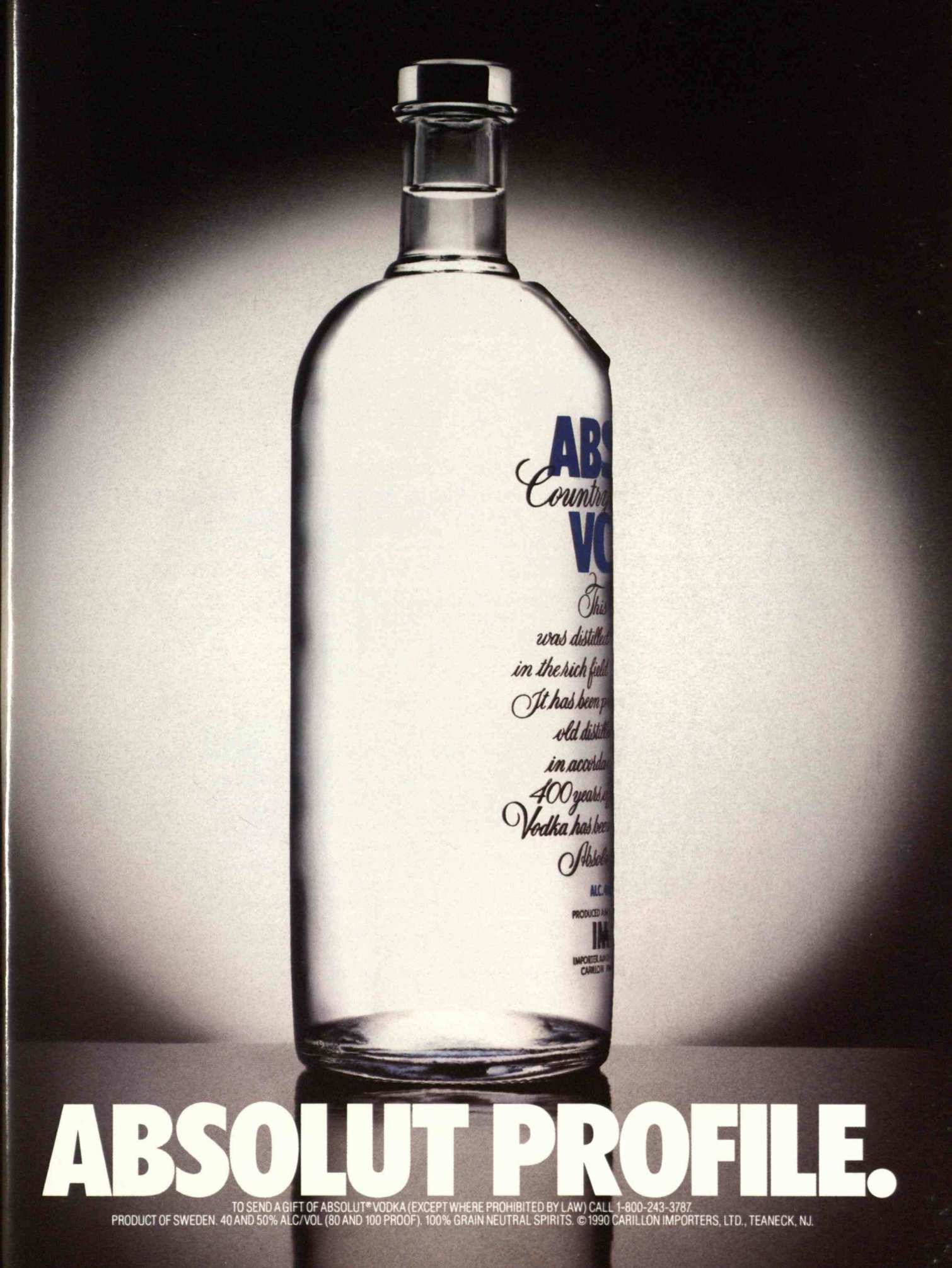
Firefighters would get information they need in a matter of minutes, compared with the current six to twelve hours. And the system might even help plan damage and rescue strategies for floods, earthquakes, oil spills, and other disasters.

Waste Convention

After a 1989 U.N. conference failed to outlaw the flow of toxic wastes to less developed nations, the Organization of African Unity moved to fashion its own agreement. The resulting Bamako Convention, which will go into force after 10 African nations ratify it, could be the world's most comprehensive toxics import ban. "Coming from a continent whose monetary wealth has declined over the last decade . . . this regional agreement should provide a global lesson," says *Greenpeace* magazine.

The convention forbids the import of hazardous and radioactive wastes into the continent without exception, and it bans toxic dumping on land and at sea. The pact also prohibits ocean incineration and the import of any hazardous substance banned, canceled, refused registration, or voluntarily withdrawn in the country of origin.

ILLUSTRATION: JON McINTOSH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